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# Computer Aided Design and Manufacturing of Composite Propfan Blades for a Cruise Missile Wind Tunnel Model

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# COMPUTER AIDED DESIGN AND MANUFACTURING OF COMPOSITE PROPFAN BLADES FOR A CRUISE MISSILE WIND TUNNEL MODEL

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## SUMMARY

One of the propulsion concepts being investigated for future cruise missiles is advanced unducted propfans. To support the evaluation of this technology applied to the cruise missile, a joint DOD and NASA test project was conducted to design and then test the characteristics of the propfans on a 0.55-scale, cruise missile model in a NASA wind tunnel (proposed NASA Technical Memorandum by E.B. Fite). The configuration selected for study is a counterrotating rearward swept propfan. The forward blade row, having six blades, rotates in a counterclockwise direction, and the aft blade row, having six blades, rotates in a clockwise direction, as viewed from aft of the test model. Figures 1 and 2 show the overall cruise missile and propfan blade configurations. The objective of this test was to evaluate propfan performance and suitability as a viable propulsion option for next generation of cruise missiles. This paper details the concurrent computer aided design, engineering, and manufacturing of the carbon fiber/epoxy propfan blades at the NASA Lewis Research Center.

## INTRODUCTION

The methodology used for the design and manufacturing of the composite propfan blades is based on a computer integrated manufacturing (CIM) approach. This approach integrates existing computer aided engineering (CAE), computer aided design (CAD), and computer aided manufacturing (CAM) software with Fortran programs written specifically for the design of propfan blades. A higher efficiency is achieved with the CIM approach by eliminating the interactive regeneration of geometric data in separate CAE, CAD, and CAM databases. The CIM approach is implemented with the CADAM computer aided design system. CADAM (trademark of CADAM INC.) is a multipurpose, high-level design and drafting package originally developed by the Lockheed Corp. A modular set of interactive and batch programs allows the construction of geometry at a graphics display terminal or through linked Fortran batch routines.

CADAM's two-dimensional graphics and drafting (ref. 1), three-dimensional interactive (ref. 2), interactive solids design (ISD) (ref. 3), interactive user exchange (IUE) (refs. 4 and 5),



and numerically controlled machining (NC II) (ref. 6) modules are the key tools used in the design of the composite propfan blades. The flowchart shown in figure 3 displays the CADAM modules and special interface programs used to design and manufacture the composite propfan blades. These interface programs are Fortran routines written to link the CAD database with the CAE and CAM software. The programs are specifically written for the CIM application of composite and metal blade design and manufacturing.

The two-dimensional module provides drafting and dimensioning capability interactively at a terminal. The two-dimensional module also allows the user to create, file, plot, and retrieve complete production drawings. The three-dimensional module is used to interactively build wire-frame and surface models. The ISD module allows the user to create solid models using existing geometry. These models are built interactively using standard or user-defined geometric primitives. The IUE module provides the design engineer and application programmer with a collection of subroutines that allow the user interactive or batch access to the CAD database.

The NC II module allows the user to program machine tools such as lathes, mills, punches, drills, water knives, and two-, three-, or multiple-axis machines. The NC II module allows tool paths to be generated from geometry residing in the CAD database. Once a set of curves or surfaces is defined, the geometry can be used as input to the numerical control portion of the software to automatically generate a numerical control tool path for machining. Once a tool path is generated, it can be animated at the terminal to check the numerical control programming for obvious errors before a part is manufactured.

Using the appropriate CADAM modules, the geometry of the composite propfan blades was transferred in a format required by the user (i.e., analyst, designer, machinist, etc.). The interface programs provided in CADAM and those written specifically for the cruise missile propfan blades allow the geometric data to be transferred directly between the CAD database and the required CAE and CAM programs. This provides design configuration control by linking the CAD database to the CAE and CAM software. The programs also transfer results from CAE analyses to the CAD database, which is required to complete the CAD/CAM modeling and design.

## PRELIMINARY COMPUTER AIDED DESIGN

### Aerodynamic and Mechanical Geometry Description

Two baseline blade geometries were selected to start the preliminary design. The first blade design is a low-rpm, high-aspect-ratio airfoil (span/chord  $\approx 2$ ) with a hub to tip ratio of 0.5075. This design is designated as cruise missile 1 (CM-1). The second blade design is a high-rpm, low-aspect-ratio airfoil (span/chord  $\approx 1$ ) with a hub to tip ratio of 0.5862 and is designated cruise missile 2 (CM-2). Table I shows the geometric design parameters for both blade designs.

The cross-sectional geometry of both blade designs is based on NACA 16 series airfoils. The blade geometric data provided from the aerodynamic design is a series of planar airfoil cross sections defined along a stacking axis that extends out the spanwise direction of the blade. The blade definition and the right-hand rectangular coordinate system that was used for the CAE, CAD, and CAM modeling is shown in figure 4. The blade lies spanwise along the x-axis, the blade chord lies generally along the y-axis, and the z-axis is through the blade thickness. Blade geometry is defined at the operating conditions and is often called as the "hot shape." This geometry is achieved when the appropriate centrifugal and aerodynamic loadings are applied during operation.

The blade chord tapers substantially from base to tip for both designs. The sweep varies for each design and will be described further in the following sections. The forward blade design for each counterrotating set includes considerable twist at the base to correct the geometry for



the boundary-layer flow. The aft blade of each set does not contain any additional twist for the boundary-layer correction.

Because of the size and configuration of the cruise missile model, the 14 by 14 ft wind tunnel at the NASA Ames Research Center was used for aerodynamic testing. Testing in the NASA Ames Research Center wind tunnel required the airfoil of the propfan blades to be of a solid composite construction to eliminate the possibility of damage to the wind tunnel fan, which is downstream of the tunnel test section. Damage would occur if any metallic blade elements were lost from the model during testing and impacted the wind tunnel fan. The thickness ratios for both designs were increased to allow sufficient thickness for the composite fabrication at the leading and trailing edges. The leading and trailing edges have additional thickness to ensure that a minimum of two composite plies exists at the edges of the blade. Both designs have a composite airfoil with a centrally located shank extending from the blade base for retention in the hub system. This shank, a cylindrical metal (stainless steel) outer shell with an all-composite core, transitions loads from the blade into the hub.

### CM-1 and CM-2 Airfoil Geometry Description

Figures 5 to 15 describe the baseline composite propfan geometries and geometric design iterations for the CM-1 and CM-2 designs. The CM-1 design has four geometric iterations, and the CM-2 design has five (see table I). The geometric iterations were necessary to meet the aerodynamic, structural, dynamic, and aeroelastic design requirements. A planform of each blade is shown in the figures, and the geometry is described with any changes from the baseline design. Table II shows the blade geometric parameters for the baseline and iterations of the CM-1 and CM-2 designs.

### Hot Shape Airfoil Geometry

The blade data received from the aerodynamic design is in a nondimensional form. This hot shape is read into the CAD database through a Fortran program called CRDBLD (coordinates to blade). The program is linked through the IUE module (refs. 4 and 5) to automatically create two-dimensional and three-dimensional CAD models. CRDBLD reads each cross section along the blade span from base to tip. For the aft blade the sections are mirrored about the axis of rotation to account for the opposite rotation direction of the forward blade row. Each blade section is then rotated to the appropriate setting angle supplied in the aerodynamic geometry file. The transformation performed on each blade cross section from the aerodynamic local coordinate system to a global coordinate system is shown in figure 16.

Several geometry details are now modified to satisfy manufacturing requirements. The arc defining the leading edge is bisected to form a pressure-side arc and a suction-side arc to facilitate machining. Also, for a continuous machinable surface, the slope must match at the interface between the leading-edge radius arcs and the blade surface definition. This is accomplished by assigning a slope vector to the first point of the surface spline, which is tangent to the leading-edge arcs. The trailing edge is generated by connecting the end points of the pressure- and suction-side splines with a straight line. This is completed for both the forward and the aft blade models. Figure 17 shows a typical blade cross section generated by the CRDBLD program.

A two-dimensional CAD model is now created containing the cross sections. By stacking these cross sections at their appropriate span locations, a three-dimensional wire-frame model is generated. Spanwise splines are added at discrete locations along the chord of each cross section and Coons surface patches (refs. 7 and 8) are added interactively. This completes the geometry generation functions of CRDBLD.



Finally, CRDBLD adds special CADAM attributes (numeric identifiers) to each geometric entity used to generate the CAD models. These are used to associate data generated by the analytical programs with the CAD models. This feature will be used later for hot-to-cold shape transformation. This completes CRDBLD processing, and the blade set now exists in the proper operating configuration, scale, and orientation for inspection by the designer.

### Airfoil Geometry Review and Verification

Upon completion of the two-dimensional and three-dimensional CAD models, the geometry is checked for proper definition. The correct orientation of the blade is based on the direction of angular rotation. This orientation defines setting angle, twist, face alignment, and the location of the pressure and suction surfaces. The accuracy of the airfoil surface is also reviewed by comparing the digital values of the coordinates used to construct the surface splines. Tangent pieces of geometry are checked to ensure that they connect and that their tangent slopes match accurately. The existence of any discontinuity between adjoining pieces of geometry affects the ability to perform CAM modeling. The surface must be continuous and match at all points.

An additional method to ensure that the surface was smooth and continuous uses plots of spline slope versus arc length that were generated using the three-dimensional module (ref. 2). Figure 18 presents an example of these plots for the CM-1A design. Figure 18(a) shows surface slope discontinuities for one of the blade spanwise splines. Figure 18(b) represents the same spline after data refinement; additional spanwise cross sections were added to produce a smoother surface.

### Structural Analysis Geometry

Geometry from the CAD database is used to generate input to the COBSTRAN (composite blade structural analyzer) program (ref. 9). This analysis geometry is output from the CAD database through a Fortran program called CADCOB (CADAM to COBSTRAN interface). A detailed description of the structural analysis procedure is given in references 10 and 11. The program is linked with the IUE module to automatically create the proper COBSTRAN input data. The COBSTRAN geometry input format is described in reference 12. The two-dimensional cross sectional models created with the CRDBLD program are modified to generate the analysis geometry data files. The input points of the original blade sections are spaced such that point density is greatest in the regions of highest slope change, which are the leading and trailing edges. The midchord regions (20 to 80 percent of chord) contain a lower point density. Figure 19(a) shows the point spacings for the aerodynamic input geometry.

The analysis code COBSTRAN requires point data to be equally spaced along the midcamber line. Another limitation of the analysis code requires a finite thickness at every point in the analysis data. This limits geometry definition to a finite distance away from the leading and trailing edges. The center point of the leading edge and the end of the trailing edge were selected as the chordwise limits to provide a finite thickness in the analysis model data file. The horizontal distance (the Y dimension in fig. 19(b)), between these points is divided into 20 equally spaced stations. Two analysis points, one from each airfoil surface (pressure and suction), at these stations are written to a file. Figures 19(b) and (c) show the generation and the point spacing for the structural analysis input data. This file is merged with other data to form the input deck to the analysis code.



## Hot Shape Geometry Extraction

A Fortran program called EXTPTS (extract points) was written to retrieve the desired point definition from the three-dimensional wire-frame model created by the CRDBLD program. The EXTPTS program uses the IUE module (refs. 4 and 5) to access the database. The point definition is used for the hot-to-cold shape transformation and for the solid model generation.

The output file from the EXTPTS program consists of a sorted list of coordinates describing the cross sections starting at the base of the blade and extending to the blade tip. Each section consists of a pressure and suction side where the points start at the leading edge and continue to the trailing edge. The location of spanwise splines along the chord of the cross section and the type and location of the geometric entity (i.e., pressure spline, leading-edge radius, etc.) are also identified at each cross section in the output.

## Hot Shape Solid Model Geometry

A Fortran program called ISDINP (interactive solids design input) was written to generate an ISD (interactive solid design) script text file. The ISD module (ref. 3) and the script text file containing the required ISD commands are executed to create solid geometry within the solid modeler.

To create a script text file, the final output file from the EXTPTS program is used as input for the ISDINP program. The ISDINP program then adds the appropriate ISD commands that create the solid geometry from the X,Y,Z coordinates in the EXTPTS file. The final output file contains all ISD modeler commands and the data required to generate a solid model of the airfoil.

The solid model definition is not complete until the base geometry is added to the airfoil geometry. The base, which is a cylindrical shank shell, is added interactively. Material densities are added to the model and mass property calculations are performed. The ISD mass properties shown in figure 20 are compared with the mass properties generated from subsequent finite-element analyses to verify the models and assure the all mass is included. Also in ISD, a shaded image is generated as shown in figure 21.

## FINAL COMPUTER AIDED DESIGN

After preliminary design and several analysis iterations were completed, the CM-1D and CM-2D blade designs were selected for final design and fabrication. The two final airfoil geometries were selected as the best compromise between the aerodynamic, structural, dynamic, and aeroelastic design requirements. The results from the analysis were used to complete the final design in preparation for fabrication. The following sections describe how the final manufacturing geometry is established based on the results obtained from the preliminary design procedures discussed earlier and analysis procedures presented in references 11 and 13 and in a proposed Technical Memorandum by C.J. Miller.

## Hot Shape to Cold-Shape Transformation

The hot-to-cold shape iteration procedure described in references 10 and 11 established a cold shape for the finite-element model (FEM). The hot-shape three-dimensional CAD model is corrected based on the results of the finite-element analysis. A Fortran program called DISINT (displacement interpolation) is used to transform the hot shape three-dimensional CAD model to



the cold shape. Since the coordinate values of finite-element points and the CAD points do not correlate one-to-one, the program interpolates the displacement results to account for the differences between the structural finite-element points and the CAD points. The CAD hot-shape to cold-shape transformation requires the file of hot shape CAD points obtained with the EXTPTS program, a file of the nodal points from the hot-shape finite-element model, and the displacement results from the FEM analysis. The CAD points are on the cross-sectional splines, which lie on the blade surface. The finite-element points are on the blade midcamber surface. The three-dimensional CAD model and the finite-element model had the same coordinate system definition (shown in fig. 4) and were in the same location in three-dimensional space to allow an accurate transformation to be obtained.

The program uses a sorting routine to find the three closest finite-element points to the CAD point that is being transformed. The point geometry description is shown in figure 22. The distances between the three closest finite-element points and the CAD point are also calculated. Using the file of known displacements at the finite-element points, a weighted average of the displacements is calculated based on the distances between the CAD point and the three closest finite-element points. The weighted average displacement of the three finite-element points is then applied in a negative direction to the CAD point. This procedure is repeated until all the points in the three-dimensional CAD model have been transformed. Once the transformation has been completed, a file of CAD points is generated that defines the cold shape of the blade. This file is read into the CAD database through the IUE module to create the cold-shape three-dimensional CAD model definition.

### Cold-Shape Airfoil Geometry

Next, the cold-shape coordinates are read back into the CAD database with a Fortran program called SPLINP (spline input). The SPLINP program uses the IUE module (refs. 4 and 5) to create the cold-shape three-dimensional airfoil geometry in the database.

The dataset used as input to this program is described in appendix A. Once all the points have been read and stored, IUE subroutines are used to create splines from the X,Y,Z coordinate point data. The completed wire-frame models are shown in figures 23 and 24. This three-dimensional cold-shape model is then used to create the surface models shown in figures 25 and 26. Coon's surface patches (ref. 7) are added interactively using the splines as boundary curves for the surface patches. The model is then shaded to reveal obvious irregularities in the blade surface before it is used to produce numerical control cutter location data. The shaded surface models are shown in figures 27 and 28. The surface models are used by the NC II module (ref. 6) to create the machine tool movements that are need to produce a cold-shape master blade.

### Cold-Shape Solid Model Geometry

Concurrent with the cold-shape airfoil geometry definition, a solid model of the cold-shape blade is also generated. The final output file from the hot-to-cold shape transformation is used as input to the ISDINP program. This dataset has the same format as the dataset of hot-shape blade points generated by the EXTPTS points program. The same procedure used to generate the hot-shape solid model is used for the cold-shape solid model.

The same procedures used in creating the base geometry for the hot-shape solid model are used. After the cold-shape solid model is created, material densities are added to the model and mass property calculations are performed. The ISD mass properties can be compared with the mass properties generated from the finite-element analysis and with the original hot-shape solid model to verify the models. Table III shows the mass property results for both the CM-1D

and CM-2D blade. The ISD module also generates a shaded image (fig. 29). The mass property comparisons and shaded image plots are used to validate the design process by assuring that mass or design inconsistencies do not exist between the finite element and/or the CAD models.

### Base Attachment/Airfoil Transition Design

Figure 30 shows the blade shank and the airfoil to base transition region. The base attachment design used for the composite propfan blades is a solid composite cylindrical shank. The composite is enclosed with a metal (stainless steel) outer shell positioned with its axis coincident with the blade stacking axis. This shank extends below the base of the airfoil surface. The blade shank has two cylindrical sections. The first is 0.756 in. in diameter and extends 0.352 in. below the base of the blade. The second section is 0.956 in. in diameter and extends from the end of the first section to 0.601 in. below the base of the blade.

The design of the interface region between the composite airfoil and metal shell is shown in figure 31. A 0.625-in. wide by 0.750-in. long composite tab protrudes from the base of the composite airfoil into the metal shank shell. The tab is separated at its base. A wedge of chopped carbon fiber/epoxy is inserted at the center of the tab. The remaining blend areas between the tab and the metal shank shell are filled with chopped carbon fiber/epoxy to complete the transition. The analysis of the section properties used for the shell and the filler material is shown in figure 32 and table IV.

Figure 33 shows the blade shank, blade clamp, and its attachment with the hub. The blade shank fits into a pocket machined in the rotating hub. The step between the two cylindrical sections seats in the blade pocket and restrains the blade from radial movement. A blade clamp is used to provide angular retention and setting angle adjustment. The blade clamp is attached to the circumference of the 0.956-in. diameter section. The clamp has a retaining tab on its outer surface that extends into a notch within the hub blade pocket. The blade is positioned at the proper setting angle and the clamp is tightened. The blade is now constrained from angular rotation around the stacking axis.

## COMPUTER AIDED MANUFACTURING

After the final design was completed, the CAD (computer aided design) geometry was then used for CAM (computer aided manufacturing). The surface models were used for numerical control programming to machine the metal master blades. These models were also used for the generation of ply templates needed for fabrication of the composite propfan blades. The following sections describe how the CAM methods and programs use the geometry from the final design discussed earlier. All further geometry references in the "Computer Aided Manufacturing" section of this paper refer to the cold-shape manufacturing geometry. For further information on the fabrication procedures used for the composite propfan blades see reference 14.

### Metal Master Blade Numerical Control Model Description and Programming

The surface models created in the final design were used for numerical control programming required to machine the metal master blade. The Coons surface patches (ref. 7) were added interactively when the airfoil geometry was described in the final design. These surface patches used the splines created previously by the SPLINP program as the boundary curves for the surface patches.

For numerical control programming, the individual surface patches must be associated



with each other to form a composite Coons surface (ref. 8), or in CADAM terminology, a surface "NET". Each region of the blade is subdivided into a NET of surface patches. These subdivisions depend on the machining sequence, tooling, fixturing, and setup (i.e., rough machining, finish machining, etc.).

After the proper machine tool and cutter parameters have been established, the tool movements to machine a particular surface NET can be generated using the three-axis area milling software in the NC II module (ref. 6). Figures 34 and 35 show a shaded image of several machine tool movements along the tool path for NETTED surface regions on the airfoil and at the base transition. When tool movements for all of the surface NETS have been created, the information is processed, and a cutter location file for the machine tool is output. This cutter location file is then down loaded to the desired machine tool, referenced in figure 3 as the APT-AC system and postprocessor.

A simplified method for producing the blend radius between the airfoil surface and the shank region was used to reduce the modeling time. The creation of a smoother blend region requires the additional generation of complex surfaces. The geometry used proved to be the best compromise between time, cost, aerodynamic flow quality, structural integrity, and geometric complexity.

Figures 35 and 36 show the tool positions and movements for the generation of the blend radius and the blade base transition region. The transition region between the blade base and the cylindrical shank requires additional surface geometry to obtain the proper tool movements. The additional geometry has a cylindrical surface, 0.756 in. in diameter, extending from the blade base to the tangent point of the blend radius on the airfoil surface.

The 0.1875-in. blend radius between the airfoil surface and the blade shank was machined with a 0.375-in.-diameter ball end cutter, and the tool nose radius created the blend. The last complete cut on the airfoil surface, 0.1875 in. from the base of the blade, produced the blend radius (fig. 36(a)). Subsequent tool passes moved along the airfoil surface, then over the cylindrical surface region, and back onto the airfoil surface. This tool movement continued until the base of the blade was reached. The cylindrical surface was also blended back into the airfoil surface with a larger radius than the tool nose radius (i.e., 0.25 in. See fig. 36(b)). This eliminated the possibility of machining an undercut when the tool transitions from the cylindrical surface on to the airfoil surface.

### Ply Template Generation

The solid composite construction of the composite propfan blades required the development of an improved computer aided method for the generation of ply template shapes. Earlier composite blade designs completed at NASA Lewis were generally of a spar and shell construction. That construction, and the small quantity of test articles required, allowed a manual generation of the ply template shapes. The cruise missile propfan blades required 80 to 90 plies per blade, and approximately 125 to 150 blades were fabricated. The blade fabrication required the cutting of 10 000 to 13 000 composite plies. The development of automated computer aided design and manufacturing methods for generating and cutting these ply shapes improved the manufacturing quality and efficiency. This procedure also accelerated the blade fabrication process. The following sections describe the CAD/CAM methods developed for ply template generation and cutting.

### Geometry Extraction for Ply Templates

Using the surface models created in the final design, the process for generating ply

templates was initiated concurrently with the CAM modeling for the metal master blades. A Fortran program, MIDSUR (midcamber and surface points), extracted the points defining the surface of the propfan blade from the CAD database using IUE subroutines (refs. 4 and 5). Once the surface points were extracted from the model, they were bisected, thus creating a midcamber surface between the pressure and suction surfaces of the airfoil. The points on the airfoil and midcamber surfaces were written to a file that was used in the generation of three-dimensional ply templates.

### Three-Dimensional Ply Template Generation

The Fortran program 3DPLY (three-dimensional ply template generator) was used to generate the three-dimensional ply surfaces. This program can be broken into four sections. The first offsets the surface points towards the center of the blade (i.e., towards the midcamber surface). The points are offset normal to the airfoil surface by a distance equal to the thickness of the composite material. This process is repeated for each consecutive ply surface using the points defined on the previous ply surface. Figures 37 and 38 show the generation of the offset ply surfaces and the generation of the ply boundaries. After the points on the ply surface have been defined, the program locates the intersection of the ply surface with the midcamber surface.

The second section of the program creates a series of lines connecting the ply surface points along the chord and along the span of the blade. This generates a grid of lines on the ply surface. The program then searches all the grid lines on the ply surface and identifies the grid lines on the ply surface that pierce the midcamber surface. Section two does not actually find the piercing points, but brackets the piercing points and saves these locations as "bracketing points". The program logic for finding the bracketing points is to compute the distance from the ply surface to the midcamber surface. When this distance goes from positive to negative, the ply surface pierces the midcamber surface. Then four bracketing points lying on the ply surface (1P, 2P, 3P, and 4P; see fig. 38) and the "bracketing points" lying on the midcamber surface (1M, 2M, 3M, and 4M; see fig. 38) are found.

After the bracketing points are found, two curves in space are defined, each containing four points. The four points 1M, 2M, 3M, and 4M on the midcamber surface define curve 1. The four points 1P, 2P, 3P, and 4P on the ply surface define curve 2. The intersection of the two curves is the boundary point of the ply surface. Sections three and four of the program calculate the approximate intersection or boundary point.

Section three of the program transforms the four points in curve 1 and the four points in curve 2 from the global  $X, Y, Z$  coordinate system to a local  $A, B, C$  coordinate system. After this transformation, the four points on the midcamber surface and the four points on the ply surface all lie either on the  $AB$  plane or close to the  $AB$  plane; that is, the  $C$  coordinates of these points are zero or near zero. After performing this transformation, section four finds the approximate intersection of curves 1 and 2. Curves 1 and 2 do not actually intersect, but the difference in the  $C$  coordinates of the two curves is very small at the "intersection." The correct transformation and projection of curves 1 and 2 onto the  $AB$  plane of the local coordinate system allows a good approximation of the boundary point to be found. Figure 38 shows the ply boundary generation and the curves in the global and local coordinate systems.

The first three sections of the program involve mainly theories and formulas from the area of solid analytical geometry. In the fourth section the most important tool used is a Hermite cubic polynomial, which includes, as part of the polynomial, first derivatives computed using Butland's modified formula (refs. 15 and 16). This is a two-dimensional local interpolation formula, called HCUBP (Hermite cubic polynomial interpolator). HCUBP interpolates between two adjacent points in the  $AB$  plane. The methodology is to project curves 1 and 2 (both three-dimensional curves) onto the  $AB$  plane and then find where these projections intersect. The



intersection point is found when the  $AB$  coordinate values satisfy the HCUBP equations for both curves. After HCUBP finds the intersection of curves 1 and 2 in the  $AB$  plane, it projects curve 1 onto the  $BC$  plane to find the  $C$  coordinate of this point of intersection. In its final procedure HCUBP transforms the point of intersection from the local  $A,B,C$  coordinate system into the global  $X,Y,Z$  coordinate system. This point then becomes a boundary point of the ply surface.

The above procedure is repeated for all boundary points in the ply surface and for all ply surfaces in the blade. A file of three-dimensional ply boundary points is then generated for use in creating the final two-dimensional ply shapes.

### Two-Dimensional Ply Template Generation

The file of three-dimensional ply boundary points is used to generate a CAD model of the ply template shapes. The final three-dimensional ply shapes are shown in figure 39. The file of three-dimensional ply boundary points is also used in the conversion to two-dimensional (planar) ply templates. The PLYINP (ply template input) program uses the IUE subroutines (refs. 4 and 5) to create geometry models in the CAD database.

The points for a single-ply template are read by the PLYINP program. The points are rotated so that the base of the ply is in the  $XY$  plane. The ply templates are broken up into consecutive strips that lie between spanwise cross sections defined on each ply surface. Figure 40 shows the two-dimensional ply template generation from the three-dimensional geometry using the strip method. The ply template is untwisted starting at the base and working out the span of the ply to the tip. Each strip is untwisted so that it lies in the  $XY$  plane by matching the flat planar perimeter to the twisted perimeter of each strip. The geometry of the flat planar strip is varied until the error between the two perimeters is acceptable. Once an acceptable error is reached, the next strip of the ply template is untwisted. This process is continued until all the strips of a single ply template are lying in the  $XY$  plane. The remaining plies are untwisted in the same manner until all the ply templates are lying in the  $XY$  plane.

Once the templates are untwisted, the "camber" of the ply is removed by interpolating along the spanwise and chordwise directions to obtain a correction to account for the difference between the contoured and the flat ply surfaces. This difference causes an increase in the perimeter of the flat ply template. When this is complete, flat ply template patterns have been generated. The three-dimensional and two-dimensional CAD models can be superimposed on one another to verify that the flattening process was successful. Figure 41 shows a comparison of the two-dimensional and three-dimensional ply shapes.

Additional points are now added to the boundaries of the ply templates so that the output can be used with a Gerber pattern cutting machine. The pattern cutting machine uses a numerically controlled reciprocating knife that operates at 5000 strokes per minute to cut fabric. This machine requires close point spacing since point to point straight line cutter control is used. Splines are generated through the ply template points. Additional points are generated by intersecting lines spaced every 0.050 in. with the previously generated splines. The new points defining the ply templates are now spaced approximately 0.050 in. apart. The four points that define the tab at the base of the ply are added to the file. The ply template is oriented such that the span of the ply, from base to tip, is along the  $X$ -axis. The chord of the ply, leading edge to trailing edge, is oriented along the  $Y$ -axis (fig. 44). The points are written to a file starting at the base if the ply at the leading edge. The tab points are then written to the file. The trailing edge points, from base to tip, and then the leading-edge points, from tip to base, are written to the file. The points are output in a clockwise direction.

The ply templates are stacked up, one on top of the other. A plot of the stacked templates can be generated and used to design a fixture for stacking the plies after they are cut.

The same points are written to a file where they will be unstacked and oriented according to the size and type of material used.

### Nesting Ply Templates on the Composite Material

The points generated by the PLYINP program are used as input to the NEST program. The NEST program, unstacks, and arranges the ply templates on the composite material for final cutting. The NEST program rotates the ply templates to orient the fibers of the composite material according to a stacking sequence defined by the finite-element analysis of the blade.

After the ply is rotated, the maximum horizontal and vertical values are found, and the ply coordinates are translated to their position "on" the composite material. A 0.25-in. space is left around each ply template during the nesting process. This process is repeated for every ply template. The NEST program also uses IUE subroutines (refs. 4 and 5) to automatically create a CAD model of the final nested ply template geometry on the composite material. Figure 42 shows the nested ply patterns for the CM-1D and CM-2D blade designs. This model can be output to a plotter. The plot can be used as a guide for cutting the ply templates by hand if necessary. The points used in generating the nested ply templates are also written to a file where they are used to generate a control data file for the pattern cutting machine.

### Machine Cut Ply Template Method

If a pattern cutting machine is to be used, the file of nested ply template points generated from the NEST program must be modified for use with the pattern cutting machine. An interface program, written at the NASA Ames Research Center, was modified to generate an input file compatible with a S-91 Gerber cutter C-100 controller. The interface program GERB (CAD to Gerber interface) uses the nested ply template file and adds the Gerber C-100 controller commands. These commands control the knife movements and position it with respect to the material on the cutting table. Figure 43 shows the pattern cutting machine. The data must be in absolute coordinates. Tool offsets must not be accounted for as this function is performed by the cutter control program. Input for knife rotation is not required. The cutter control program computes the necessary knife direction commands based on X,Y input data.

When cutting inside corners on the plies, for example, where the rectangular tab joins the base of the ply template, care has to be taken to avoid over cutting the tab. The knife movements for the pattern cutting machine are shown in figure 44. The first cut of each ply was from point 1 to point 2. The knife was then lifted up and positioned at point 3 where it was lowered. A cut was then made from point 3 back to point 2 thus finishing the inside corner. The same procedure was followed to produce the second inside corner (points 4, 5, and 6). For cuts without inside corners, as is the case for plies toward the center of the blade, the knife was left in the down position and the ply was cut in one pass.

### Hand Cut Ply Template Method

If the ply template shapes must be cut by hand, two procedures can be used. Both methods use the CAD geometry created by the ply template generation programs. The first method uses a hard copy plot of the nested ply template shapes (fig. 42). The plot is glued to the backing paper of the composite material using a suitable adhesive. The template shapes are cut from the composite material using hand shears.

The second method uses a metal template as a guide for marking the backing paper of



the composite material with a soft graphite marker. The metal templates are cut from sheet steel using a water knife. The nested ply shapes (fig. 42) are used by the NC II module (ref. 6) to generate the required tool movements for the water knife. When tool movements for all of the ply template shapes have been created, the information is processed into a cutter location file for the water knife, and the metal template is cut. The template is placed on the composite material and the ply shapes are traced onto the backing material using a soft graphite marker. Again, hand shears are used to cut the composite material.

### Composite Blade Manufacturing and Testing

The metal master blades and the plies cut using the methods described were required to complete the blade manufacturing process. The plies for each half of the blade airfoil (i.e., the pressure and suction sides) were sequentially stacked in a special layup fixture. The resulting airfoil preforms were assembled with the shank shell and placed in a mold. The mold was fabricated using castable tooling compounds and the metal master blade. Additional transition plies and chopped filler material were added to complete the blade assembly.

After assembly, the blade was compression molded in a hydraulic press with heated platens. The cure temperature, pressure, and closure rate of the press was controlled based on the composite material resin system. Once cured, the blade was removed from the mold and postcured in an oven. Any flash produced during the molding process was removed after postcuring. This flash was carefully removed, and the edges of the blade lightly sanded. This completed the blade manufacturing process. The blades were inspected, instrumented, and tested for quality assurance. Blades that passed inspection and quality assurance tests were shipped to NASA Ames Research Center for final assembly with the cruise missile wind tunnel model. For additional information and details of the composite propfan blade fabrication, inspection, and quality assurance testing, see reference 14.

The tests that were successfully completed in the NASA Ames wind tunnel indicate that counterrotating propfans are a very attractive propulsion concept for cruise missiles. The characteristics of the rotating propfan blades improved the airframe's basic aerodynamic performance. The propfan missile propulsion system appears to accept a wide range of flow distortion and off-design operation while maintaining high propulsive efficiency.

### CONCLUDING REMARKS

Integrating the methods for all phases of the cruise missile propfan blade CAE, CAD, and CAM design resulted in a more efficient design procedure that linked multiple phases through a common database. The efficiency was improved by eliminating the interactive regeneration of geometric data in separate CAE, CAD, and CAM databases. Improved geometric configuration control was also realized during the entire analysis, design, and manufacturing process. The methods used allow several disciplines to access the geometric blade definition from a common database when multiple computer software codes were employed.

This integration also allowed the application of enhanced concurrent engineering and manufacturing techniques. The CAD techniques for generating the surface geometry for CAM, producing required drawings, and adding changes obtained from the CAE analysis results were all processed in parallel using a single geometric database. The fabrication of one of the preliminary blade geometries was started at the initial stages of the design. This allowed the early involvement of manufacturing personnel in the design process. Several test blades were machined and inspected to ensure accuracy. Any problems encountered with tooling, fixturing, and CAM model generation were solved prior to the manufacture of the final geometry. The application of

existing CAM methods for machining the metal master blades and the development of new CIM methods for the cutting composite ply templates were started at the earliest stages of the design process.

The ability of the specialists of each discipline to work on their respective areas from the start of the design reduced the lead time required to complete the final design. This reduction was achieved by processing all of the required design data in parallel. These procedures reduce cost and produce high quality blading in a reasonable time.

#### ACKNOWLEDGEMENT

The authors are grateful for the contributions made by other NASA Lewis Research Center colleagues Bruce M. Auer, for his development of the three-dimensional ply template program, and John D. Noonan, and Nicholas P. Wolansky, for their support, assistance, and experience in the computer aided manufacturing and numerical control programming of the metal ply templates and metal master blades, respectively.



TABLE I.— CRUISE MISSLE WIND TUNNEL MODEL BLADE GEOMETRIC DESIGN PARAMETERS  
[Number of blades, 6 by 6.]

Blade design	Tip radius, in.	Hub radius, in.	Blade length, in.	Hub to tip ratio	Hub cylinder length, in.	Tip speed, ft/sec	Rotational speed	
							rpm	rps
CM-1	8.375	4.250	4.125	0.5075	7.000	700.0	9 578.0	159.6
CM-2	7.250	4.250	3.000	0.5862	7.000	900.0	14 225.6	237.1

TABLE II. — GEOMETRIC DESIGN PARAMETERS

Blade design	Aspect ratio	Base chord, in.	Tip chord, in.	Sweep angle, deg	Twist angle difference at base and tip, $\Delta\theta$ , deg		Increase in thickness from baseline, percent	Increase in camber from baseline, percent
					Forward blade	Aft blade		
Baseline design, CM 1								
CM-1	1.842	2.736	1.072	25.78	19.82	14.80	- - -	- - -
CM-1A	1.842	2.736	1.072	25.78	19.82	14.80	8.0	0
CM-1B	1.934	2.750	0.842	24.77	12.80	14.95	8.8	15.0
CM-1C	1.847	2.733	1.072	29.81	12.77	14.96	10.8	0
CM-1D	1.933	2.750	0.842	24.79	12.80	14.95	10.8	15.0
Baseline design, CM 2								
CM-2	1.087	3.474	1.425	36.87	17.58	13.42		
CM-2A	1.079	3.428	1.424	36.87	15.96	13.19	5.0	0
CM-2B	1.186	3.130	1.283	39.96	16.03	13.19	5.0	4.0
CM-2C	1.186	3.130	1.283	30.27	16.03	13.19	5.0	4.0
CM-2D	1.186	3.130	1.283	18.37	16.03	13.19	5.0	4.0
CM-2E	1.205	3.137	1.069	49.72	16.34	13.34	5.0	6.24

TABLE III. — CM-2D COLD-SHAPE MASS PROPERTIES

	CM 1D		CM 2D	
	Forward blade	Aft blade	Forward blade	Aft blade
Mechanical properties: Volume, in. Weight, lb	1.4095 0.1043	1.4069 0.1042	1.0969 0.0865	1.0946 0.0864
Center of gravity, in.:				
X	4.5614	4.5616	4.3129	4.3132
Y	0.0329	0.0309	0.0061	0.0054
Z	0.0304	-0.0343	0.0146	-0.0158
Planar moments of inertia, lb·in. <sup>2</sup> :				
YZ	0.1171	0.1169	0.0667	0.0667
XZ	0.0227	0.0214	0.0157	0.0157
XY	0.0070	0.0082	0.0094	0.0093
Axial moments of inertia, lb·in. <sup>2</sup> :				
XX	0.0297	0.0296	0.0250	0.0250
YY	0.1241	0.1251	0.0761	0.0760
ZZ	0.1398	0.1383	0.0824	0.0824
Axial radii of gyration, in.:				
XX	0.5336	0.5331	0.5381	0.5376
YY	1.0906	1.0960	0.9381	0.9382
ZZ	1.1575	1.1523	0.9763	0.9769
Products of inertia, lb·in. <sup>2</sup> :				
YZ	0.0085	-0.0094	0.0088	-0.0087
XZ	0.0062	-0.0070	0.0023	-0.0024
XY	0.0102	0.0096	0.0025	0.0024
Polar moment of inertia, lb·in. <sup>2</sup>	0.1468	0.1465	0.0918	0.0917
Polar radius of gyration, in.	1.1861	1.1860	1.0302	1.0304
Direction cosines principal axes, x,y,z	-0.9917, -0.1116, -0.0635 -0.1276, 0.9123, 0.3892 -0.0145, -0.3941, 0.9190	-0.9919, -0.1051, 0.0717 -0.1262, 0.8847, -0.4488 0.0162, 0.4542, 0.8908	-0.9971, -0.0575, -0.0493 -0.0754, 0.8168, 0.5720 -0.0074, -0.5741, 0.8188	-0.9972, -0.0555, 0.0502 -0.0742, 0.8192, -0.5686 0.0095, 0.5707, 0.8211
Axial moments	0.0281 0.1219 0.1435	0.0281 0.1217 0.1433	0.0248 0.0702 0.0886	0.0247 0.0702 0.0885

<sup>a</sup> Global cartesian coordinate system<sup>b</sup> Centroidal coordinate system



TABLE IV. — BLADE BASE SECTION PARAMETERS  
[See fig. 32.]

Area number	Area, in. <sub>2</sub>	X bar, in.	Y bar, in.	Moment of inertia, I, in.			Radius of gyration, R, in.			Zeta	Polar moment of inertia, IP, in.		Polar radius of gyration, RP, in.	
				Y-Y	X-Y	X-X	Y-Y	Y-Y	X-X		Y-Y	X-X	Y-Y	X-X
Section B-B														
1	0.089	0	0	0.006	0	0.006	0.254	0.254	45.00	0.006	0.006	0.254	0.254	
2	0.168	0	0	0.009	0	0.003	0.231	0.143	0	0.009	0.003	0.231	0.143	
3	0.018	0	0	0	0	0.001	0.008	0.195	0	0	0.001	0.008	0.195	
4	0.174	0	0	0.001	0	0.006	0.087	0.189	0.001	0.001	0.006	0.087	0.189	
Section C-C														
1	0.089	0	0	0.006	0	0.006	0.254	0.254	45.00	0.006	0.006	0.254	0.254	
2	0.006	0	0	0.001	0	0	0.326	0.052	-0.003	0.001	0	0.326	0.052	
3	0.176	0	0	0.001	0	0.005	0.081	0.176	0	0.001	0.005	0.081	0.176	
4	0.178	0	0	0.008	0	0.005	0.219	0.165	0	0.008	0.005	0.219	0.0655	

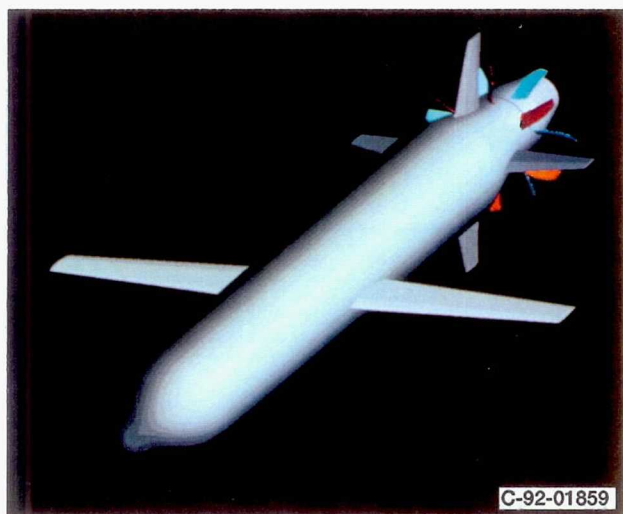


Figure 1.—Solid model of cruise missile configuration.



Figure 2.—Solid model of propfan blade configuration.

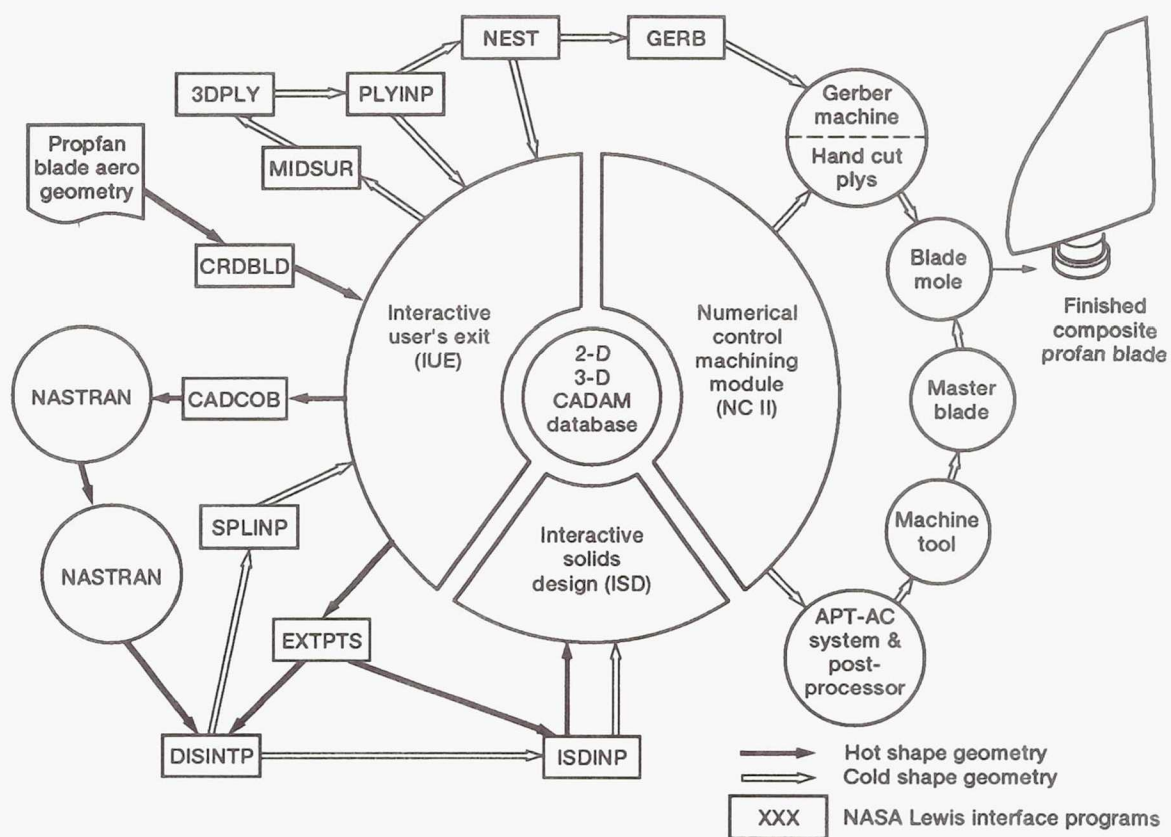


Figure 3.—Computer integrated manufacturing of composite propfan blades.



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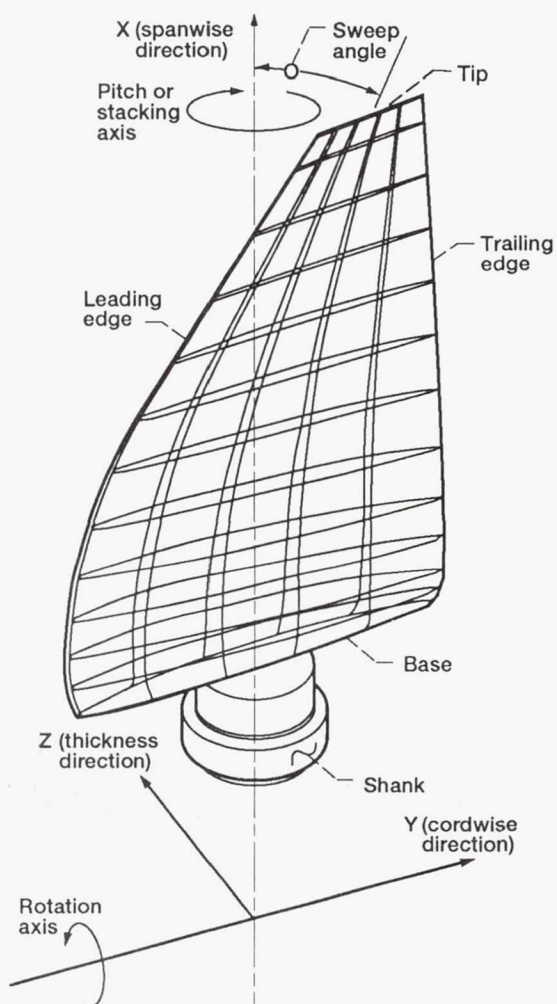


Figure 4.—Blade definition and coordinate system.

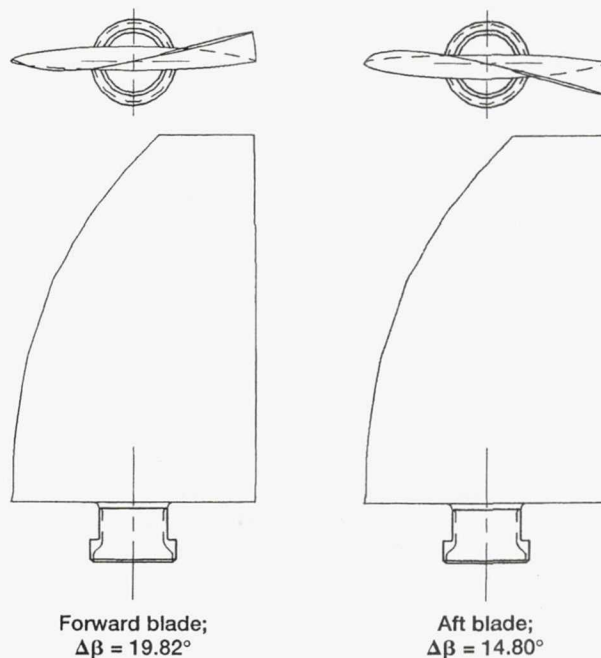


Figure 6.—CM-1A blade design: CM-1 airfoil geometry plus 8 percent increase in midspan. Aspect ratio, 1.8415; base chord, 2.736 in.; tip chord, 1.072 in.; sweep angle, 25.78°.

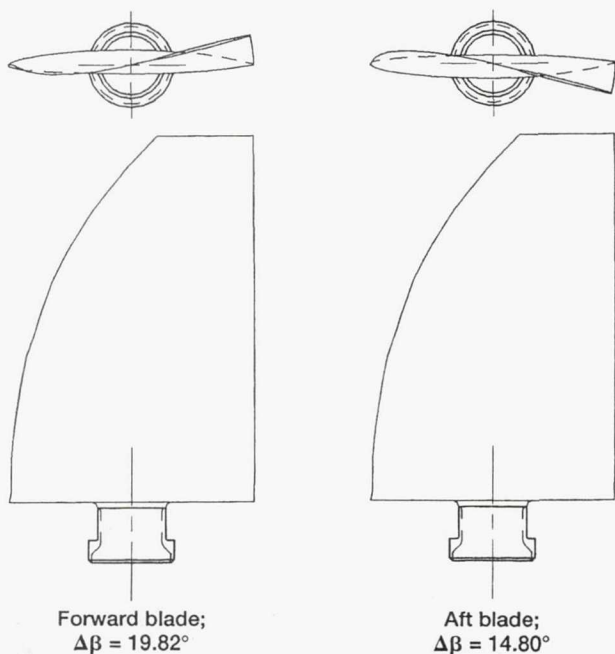


Figure 5.—CM-1 blade design: baseline airfoil geometry. Aspect ratio, 1.8415; base chord, 2.736 in.; tip chord, 1.072 in.; sweep angle, 25.78°.

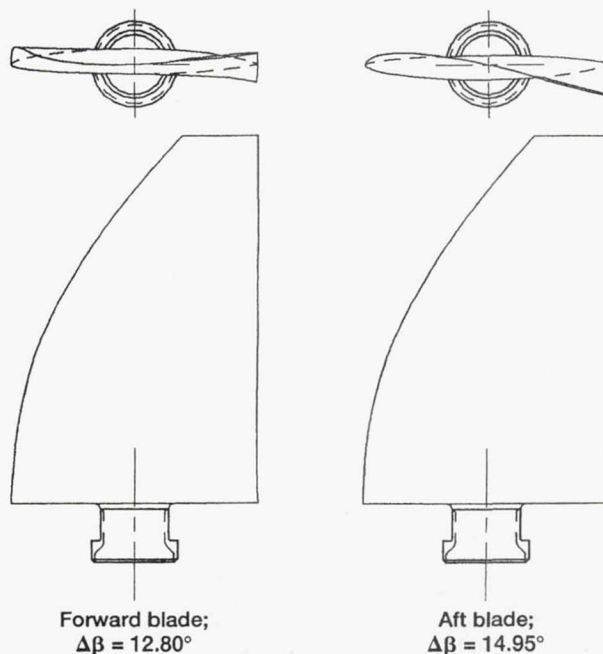
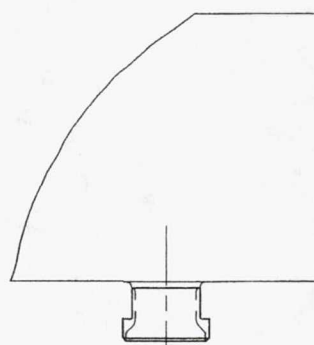
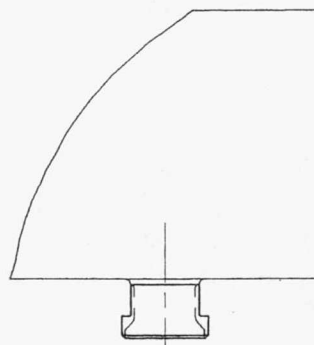
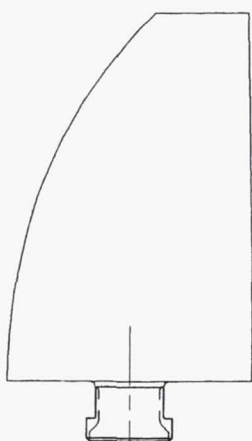
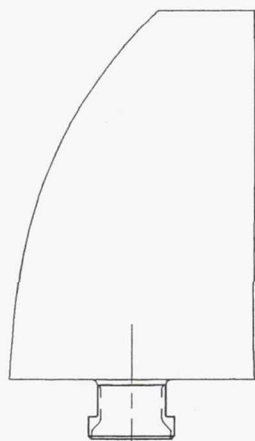
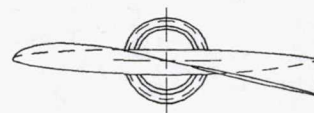
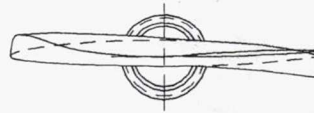
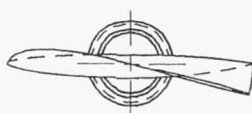
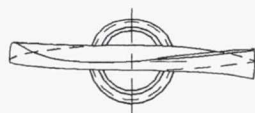


Figure 7.—CM-1B blade design: CM-1A airfoil geometry plus 15 percent increase in outboard camber. Aspect ratio, 1.9338; base chord, 2.750 in.; tip chord, 0.842 in.; sweep angle, 24.77°.





Forward blade;  
 $\Delta\beta = 12.77^\circ$

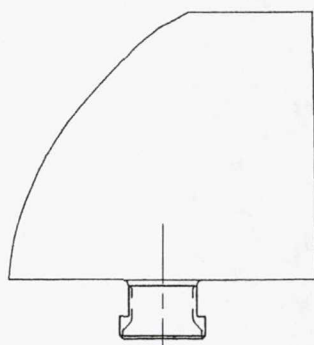
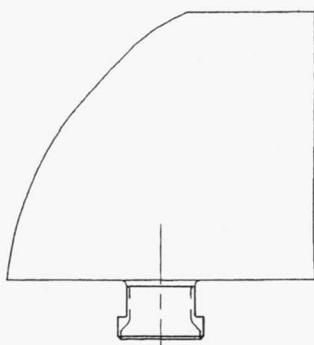
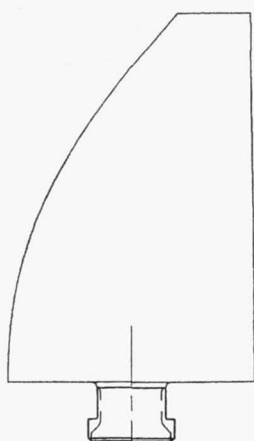
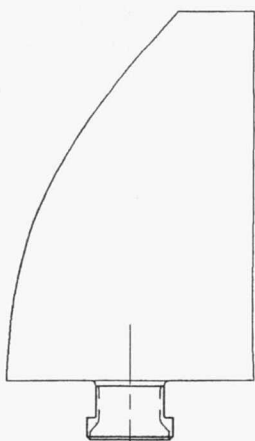
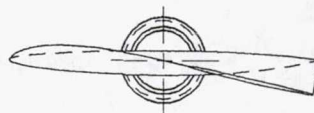
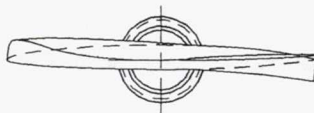
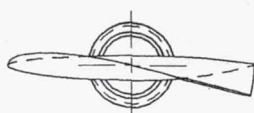
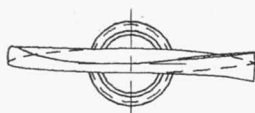
Aft blade;  
 $\Delta\beta = 14.96^\circ$

Forward blade;  
 $\Delta\beta = 17.58^\circ$

Aft blade;  
 $\Delta\beta = 13.42^\circ$

Figure 8.—CM-1C blade design: CM-1A airfoil geometry plus 10 percent increase in midspan thickness. Aspect ratio, 1.8473; base chord, 2.733 in.; tip chord, 1.072 in.; sweep angle, 29.81°.

Figure 10.—CM-2 blade design: baseline airfoil geometry. Aspect ratio, 1.0865; base chord, 3.474 in.; tip chord, 1.425 in.; sweep angle, 36.87°.



Forward blade;  
 $\Delta\beta = 12.80^\circ$

Aft blade;  
 $\Delta\beta = 14.95^\circ$

Forward blade;  
 $\Delta\beta = 15.96^\circ$

Aft blade;  
 $\Delta\beta = 13.19^\circ$

Figure 9.—CM-1D blade design: CM-1B airfoil geometry plus 10 percent increase in thickness. Aspect ratio, 1.9334; base chord, 2.750 in.; tip chord, 0.842 in.; sweep angle, 24.79°.

Figure 11.—CM-2A blade design: CM-2 airfoil geometry plus 5 percent increase in midspan thickness. Aspect ratio, 1.0790; base chord, 3.428 in.; tip chord, 1.424 in.; sweep angle, 36.87°.

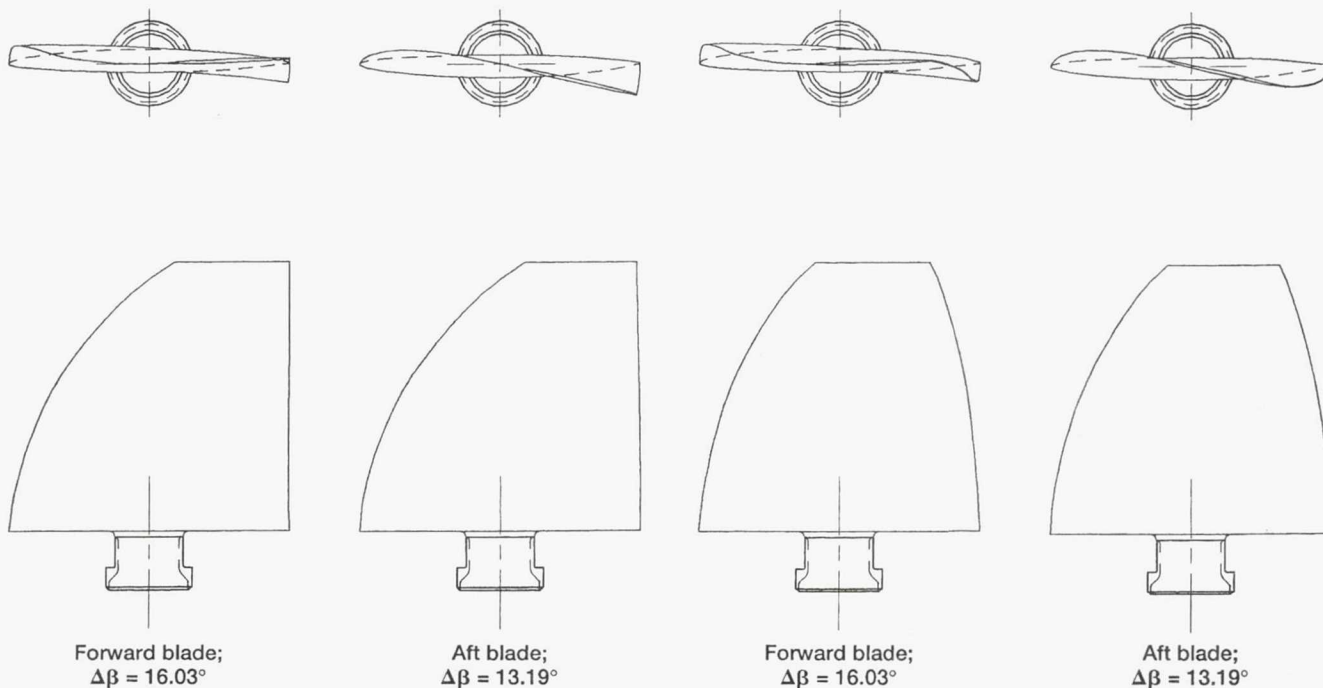


Figure 12.—CM-2B blade design: CM-2A airfoil geometry plus 4 percent increase in chamber. Aspect ratio, 1.1857; base chord, 3.130 in.; tip chord, 1.283 in.; sweep angle,  $39.96^\circ$ .

Figure 14.—CM-2D blade design: CM-2B airfoil geometry plus forward sweep on trailing edge (straight line at 70 percent of chord). Aspect ratio, 1.1858; base chord, 3.130 in.; tip chord, 1.283 in.; sweep angle,  $18.37^\circ$ .

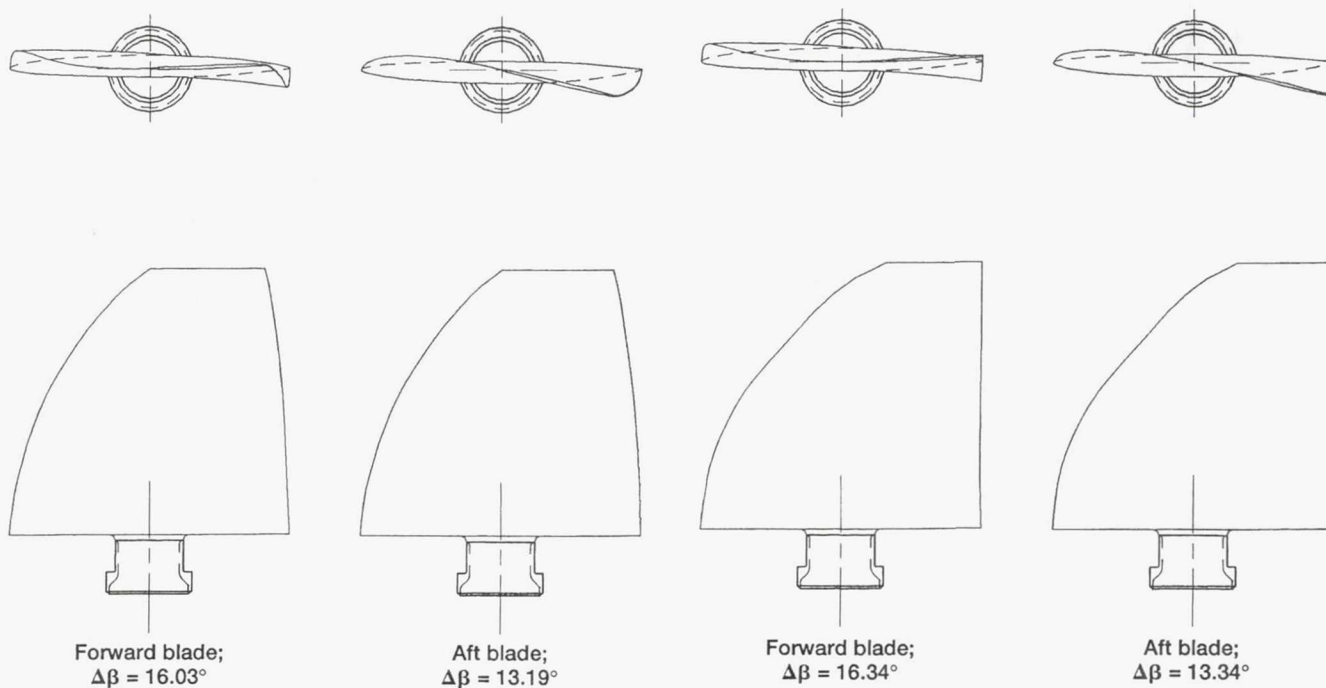
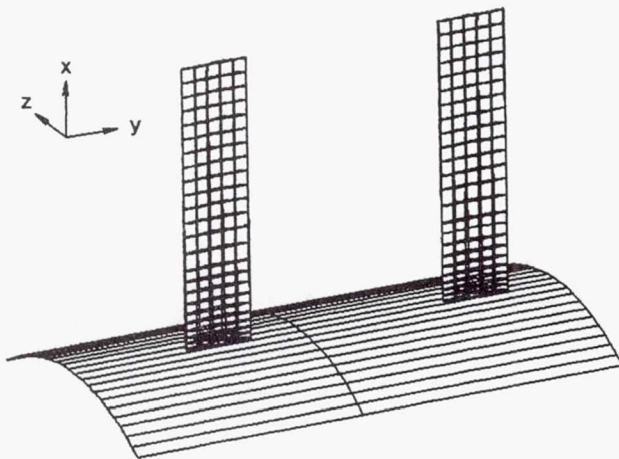


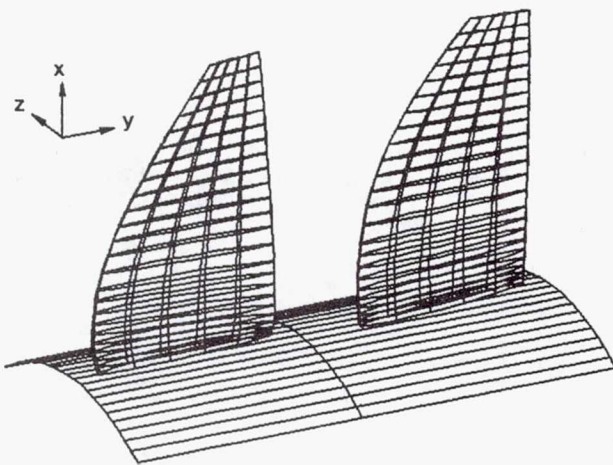
Figure 13.—CM-2C blade design: CM-2B airfoil geometry plus forward sweep on trailing edge (straight line at 85 percent of chord). Aspect ratio, 1.1859; base chord, 3.130 in.; tip chord, 1.283 in.; sweep angle,  $30.27^\circ$ .

Figure 15.—CM-2E blade design: CM-2B airfoil geometry plus 6 percent increase in outboard camber. Aspect ratio, 1.2048; base chord, 3.137 in.; tip chord, 1.069 in.; sweep angle,  $49.72^\circ$ .

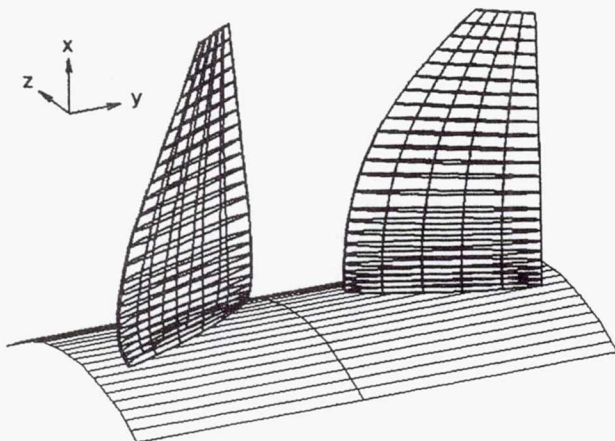




(a) Nondimensional blades in local coordinate system.



(b) Scaled blades in global coordinate system.



(c) Blades rotated to setting angle (operating position).

Figure 16.—Coordinate transformation.

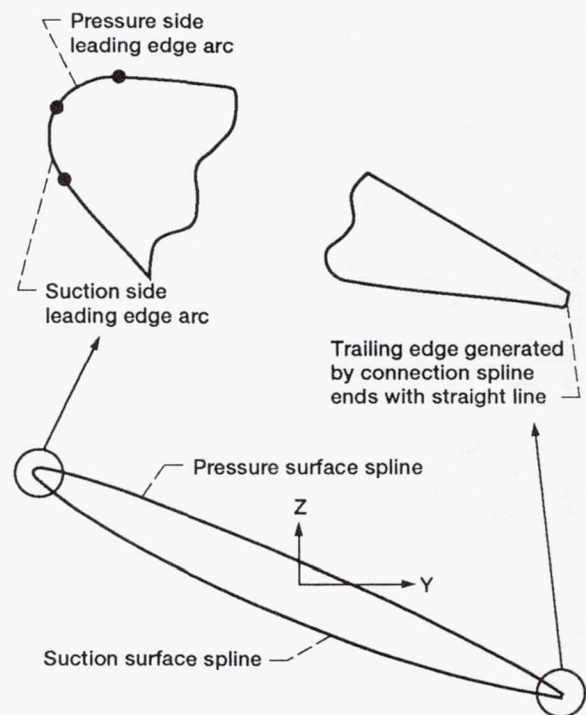


Figure 17.—Cross section of typical blade.

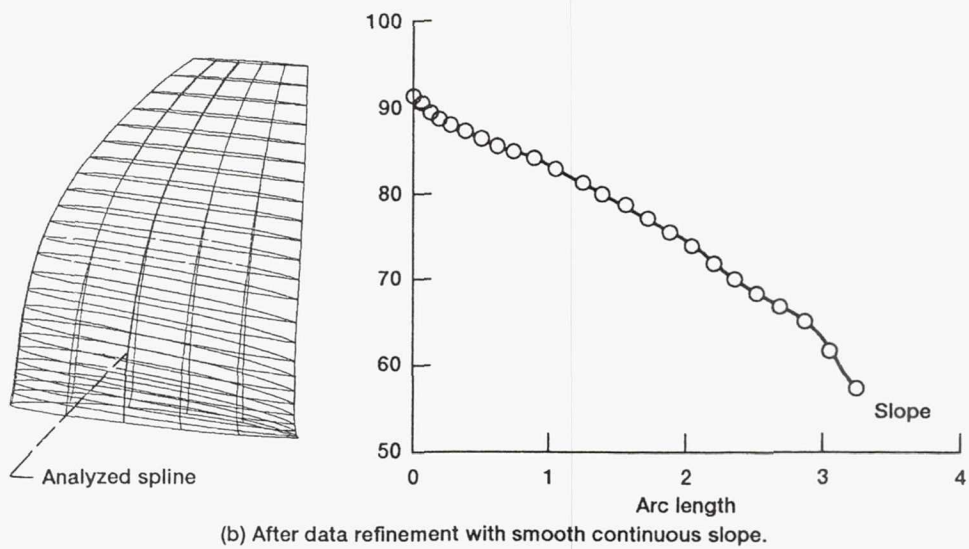
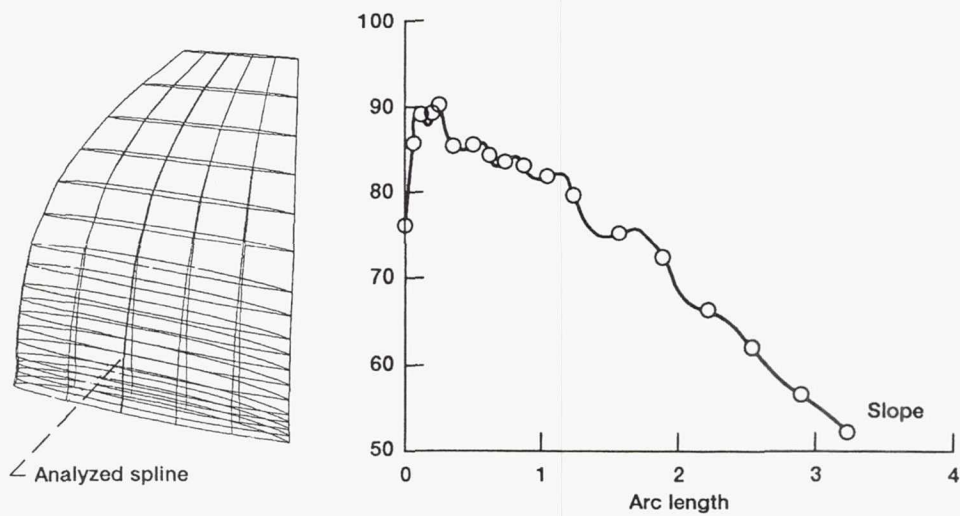
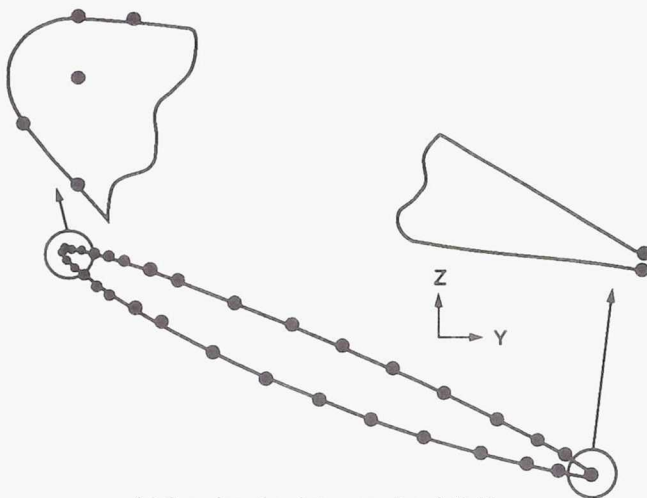


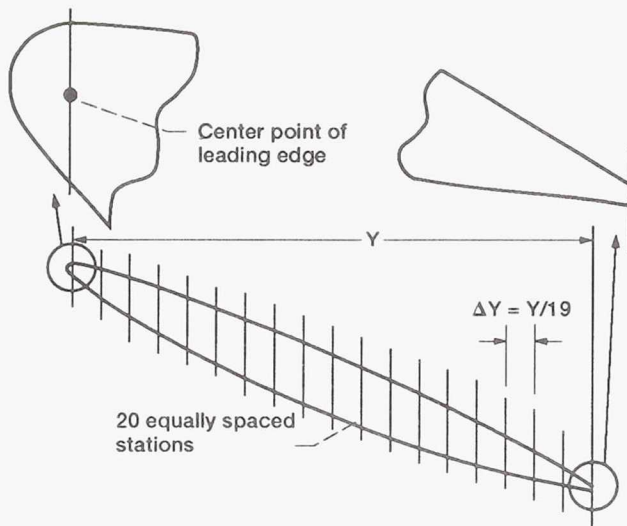
Figure 18.—Spanwise surface spline.



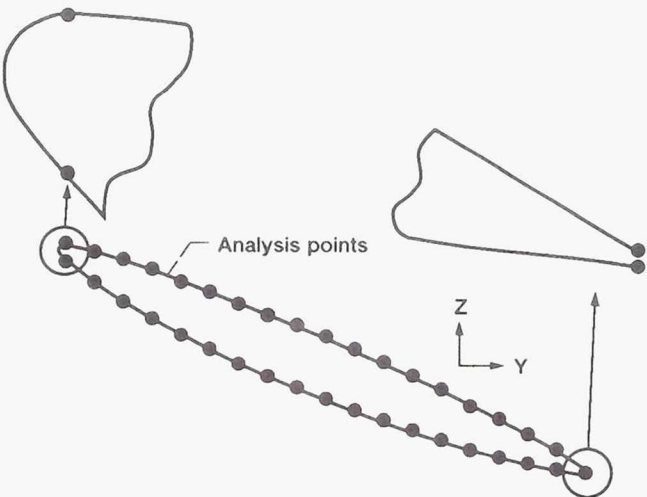
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(a) Aero input point geometry definition.



(b) Generation of COBSTRAN input point data.



(c) CADCOB output point geometry definition (COBSTRAB input definition).

Figure 19.—Structural geometry definition.

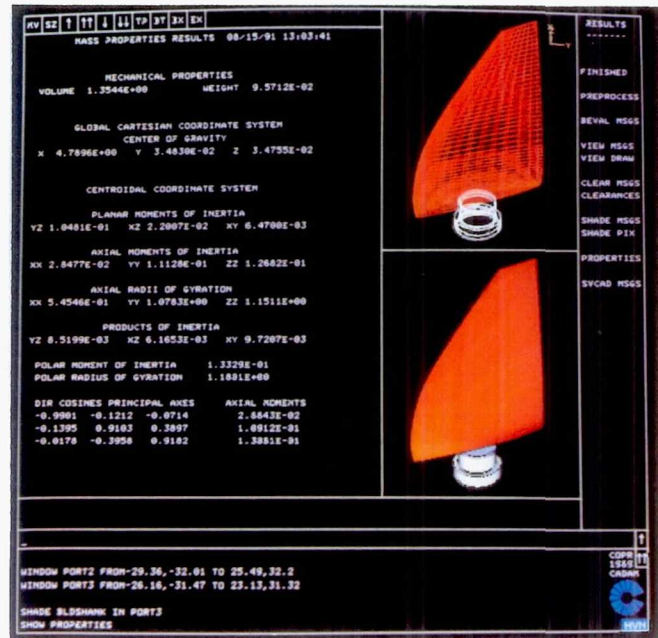


Figure 20.—CM-1D Example of solid model and mass properties screen.

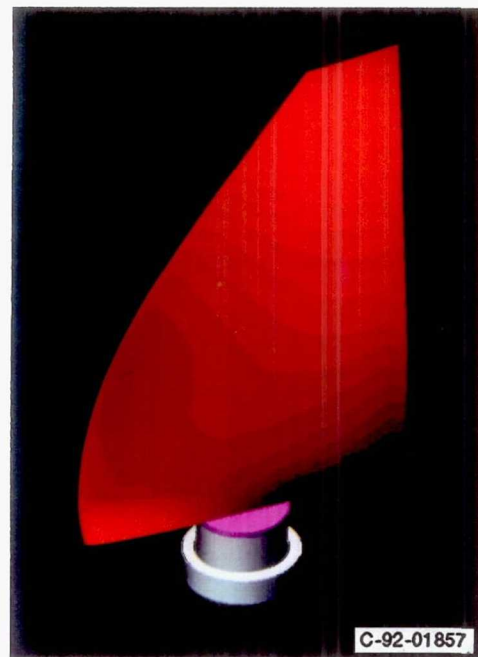


Figure 21.—Shaded solid model CM-1D hot shape airfoil.



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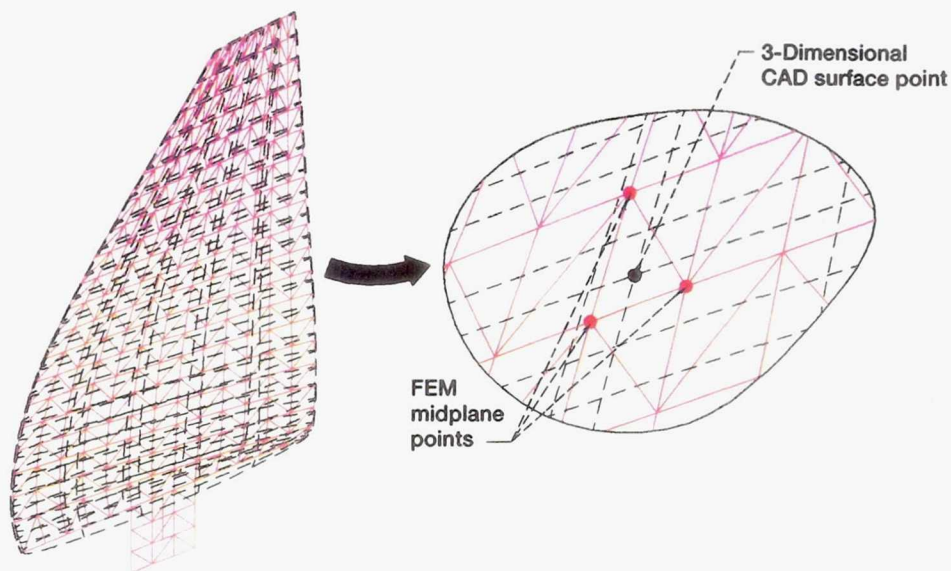
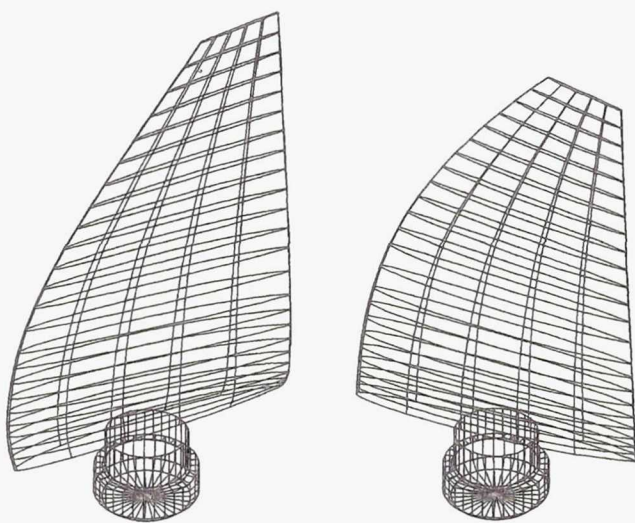
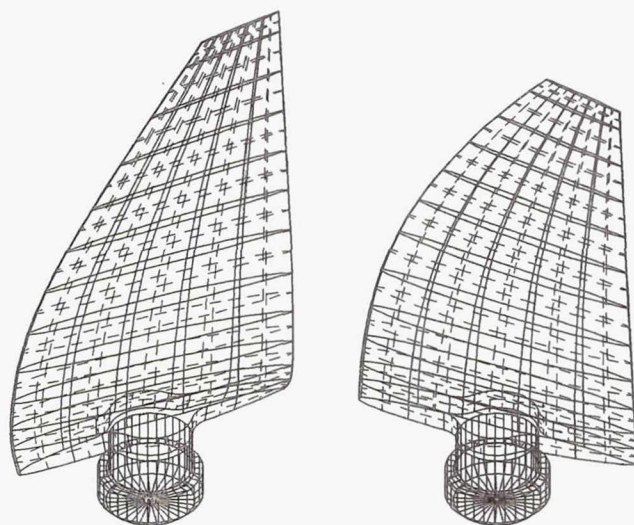


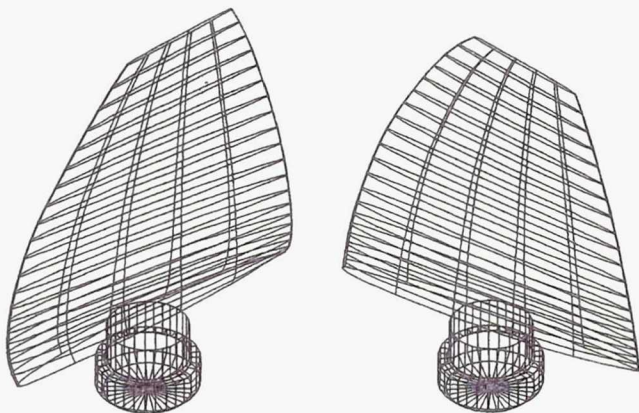
Figure 22.—Hot to cold shape transformation from finite-element method (FEM) results.



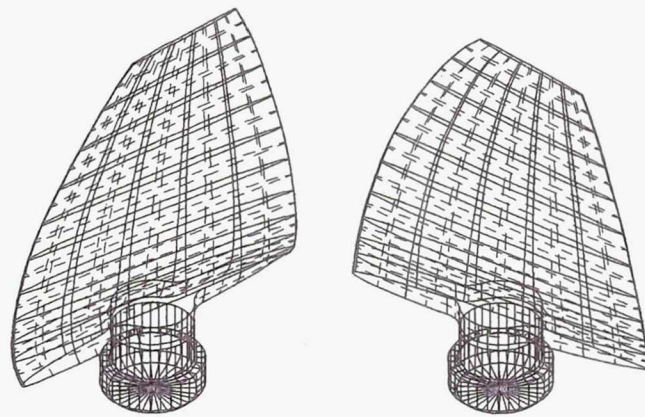
Forward blade  
Aft blade  
Figure 23.—CM-1D three-dimensional wireframe model.



Forward blade  
Aft blade  
Figure 25.—CM-1D cam surface model.



Forward blade  
Aft blade  
Figure 24.—CM-2D three-dimensional wireframe model.



Forward blade  
Aft blade  
Figure 26.—CM-2D cam surface model.



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Figure 27.—CM-1D shaded cam surface models.

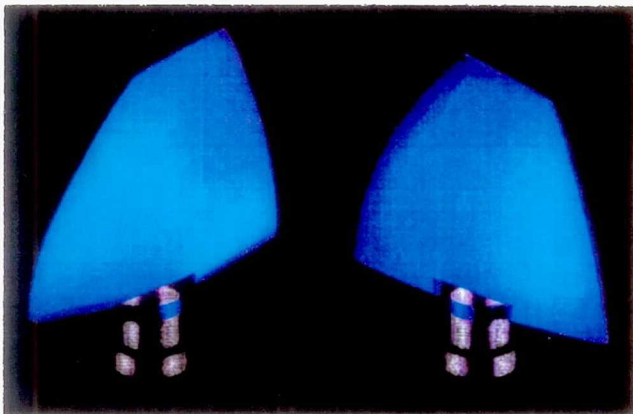


Figure 28.—CM-2D shaded cam surface models.



Figure 29.—Shaded solid model CM-1D cold shape airfoil.



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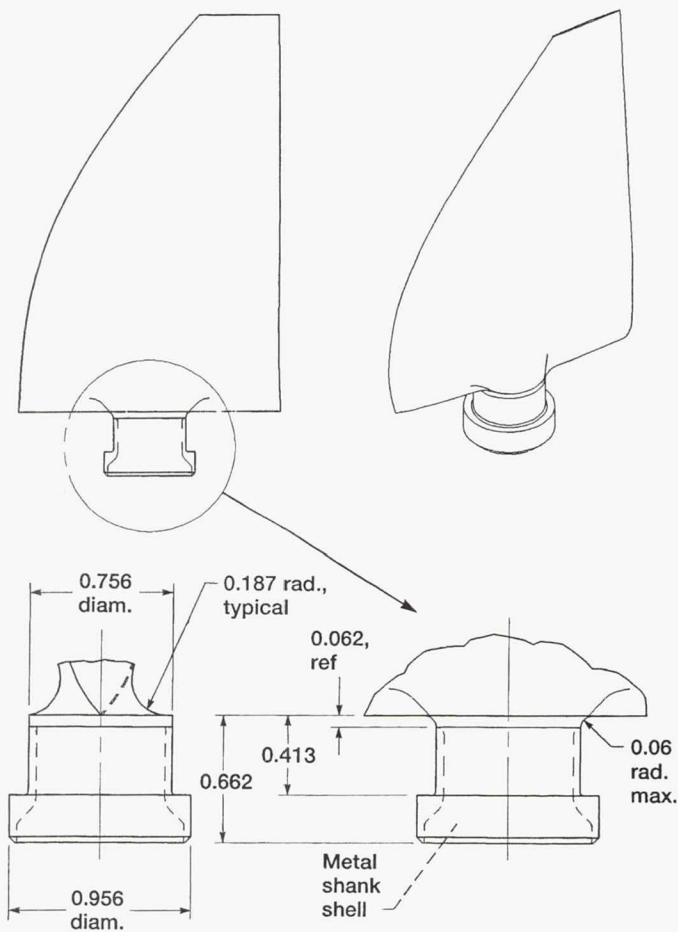


Figure 30.—CM blade base and airfoil transition region. (Dimensions are in inches).

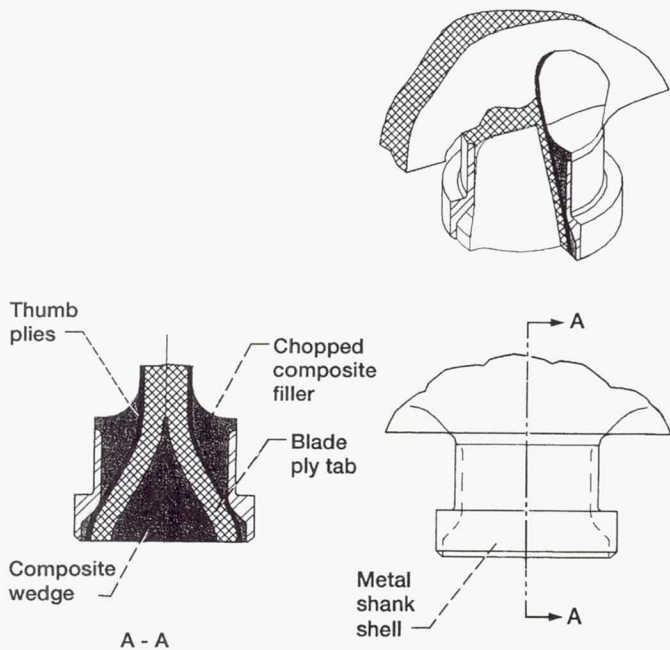


Figure 31.—CM blade metal shell to airfoil attachment design.

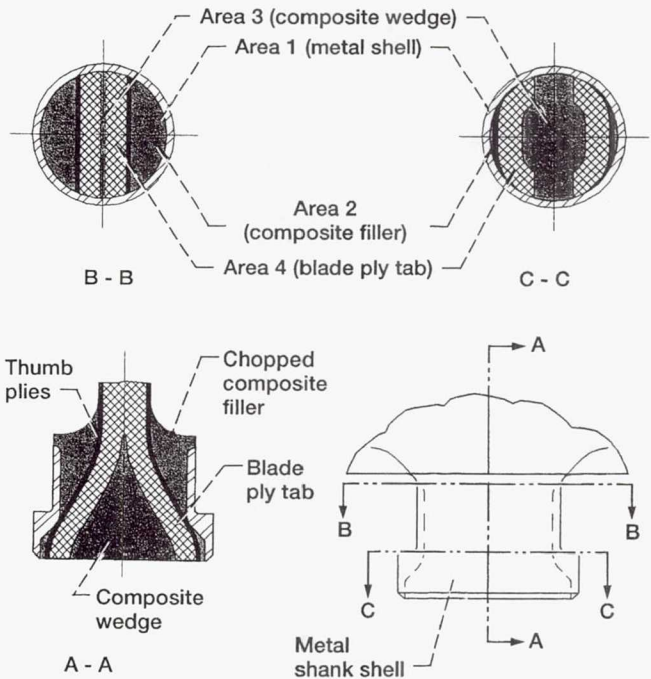


Figure 32.—CM blade base section properties.

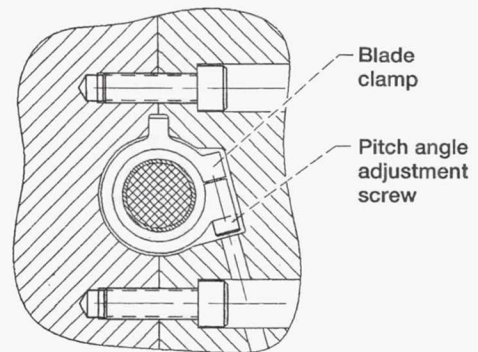


Figure 33.—CM blade base and hub attachment design.

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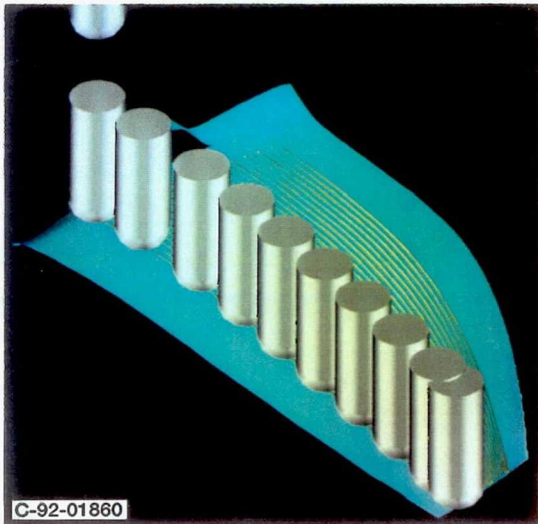


Figure 34.—Numerical control tool paths across blade airfoil surface.

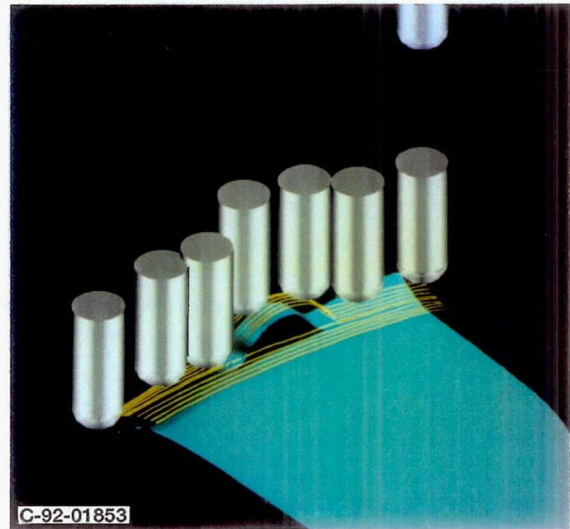
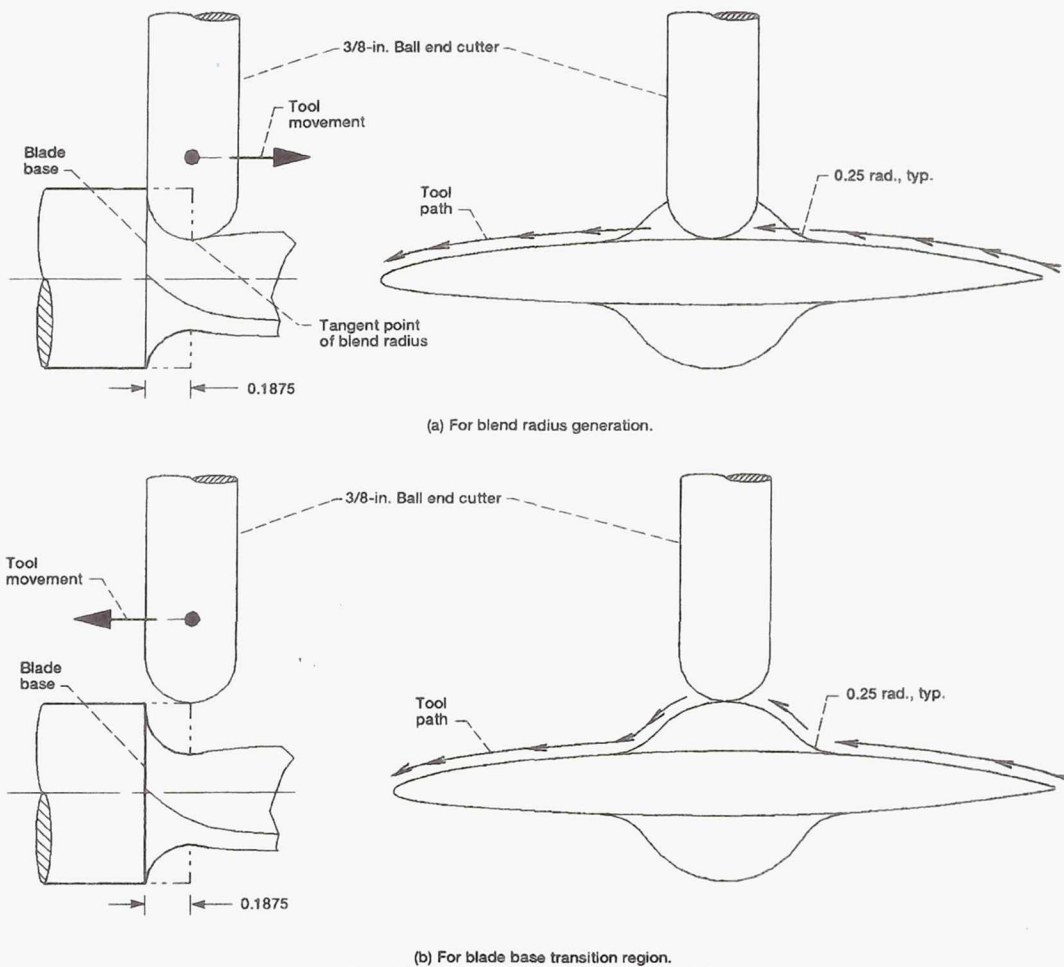
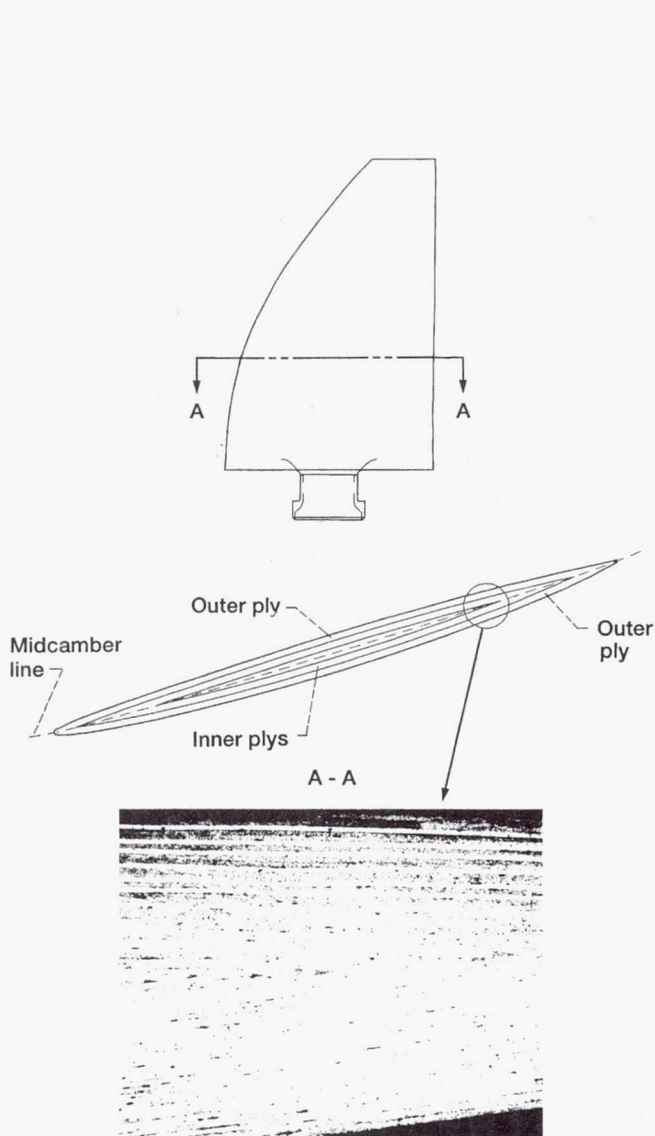


Figure 35.—Numerical control tool paths across base transition region.



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Cross section of fabricated composite blade  
Figure 37.—Generation of offset ply surfaces.

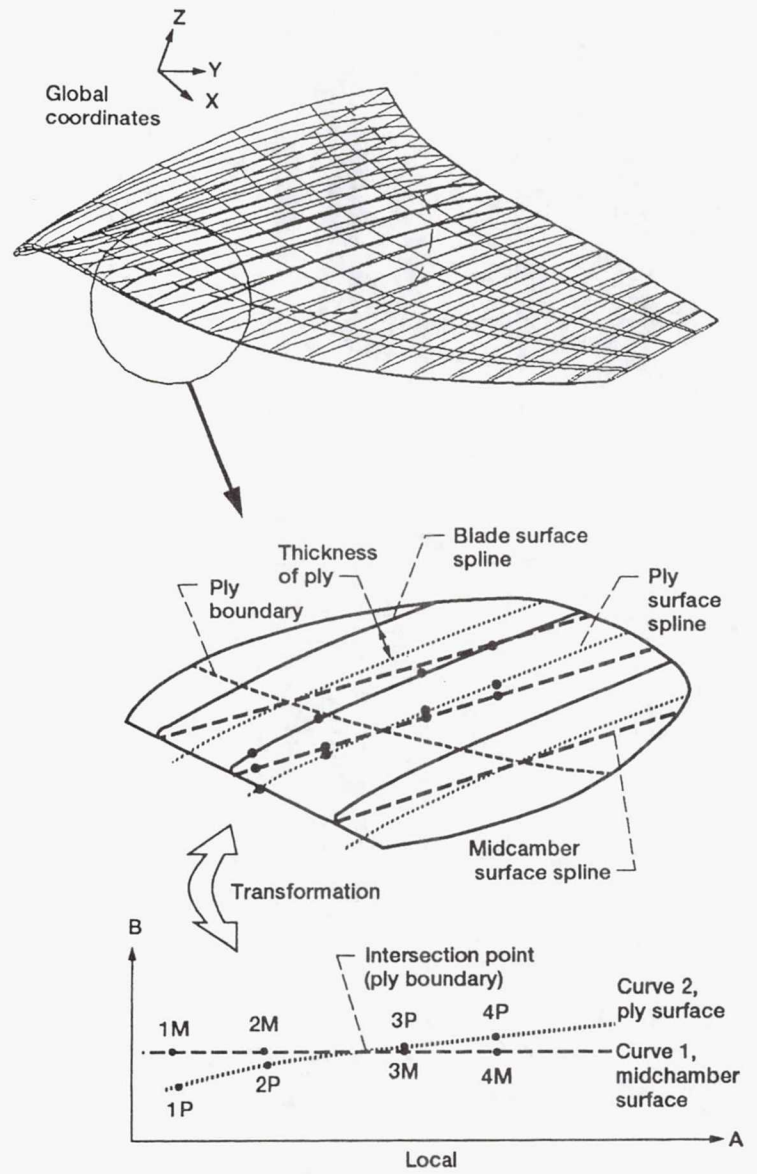


Figure 38.—Three-dimensional ply boundary generation.



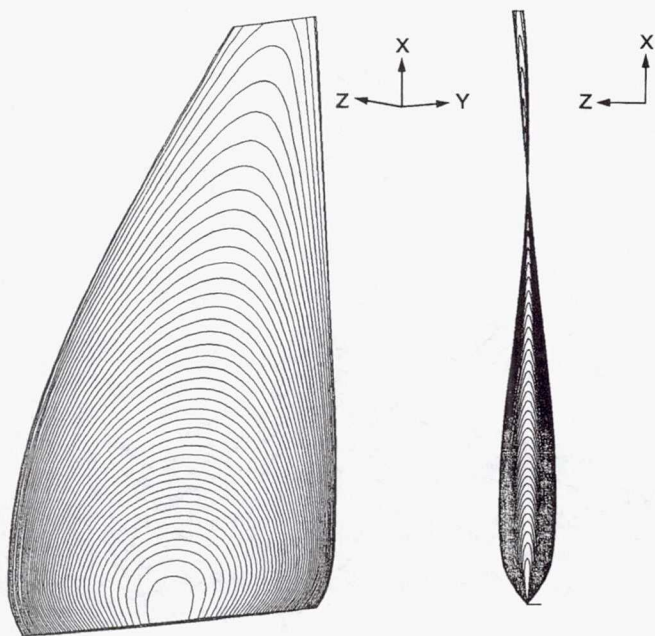


Figure 39.—Three-dimensional ply template shapes.

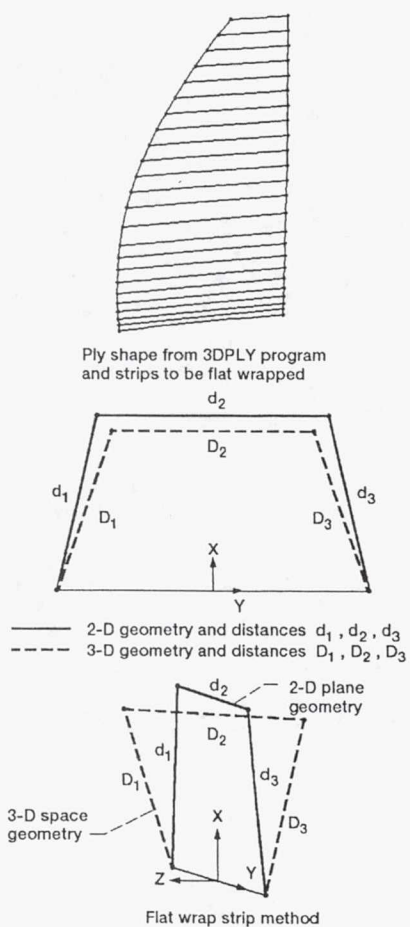


Figure 40.—Two-dimensional ply template generation from three-dimensional geometry.  $D_1 = d_1$ ,  $D_2 = d_2$ , and  $D_3 = d_3$  (with acceptable error).

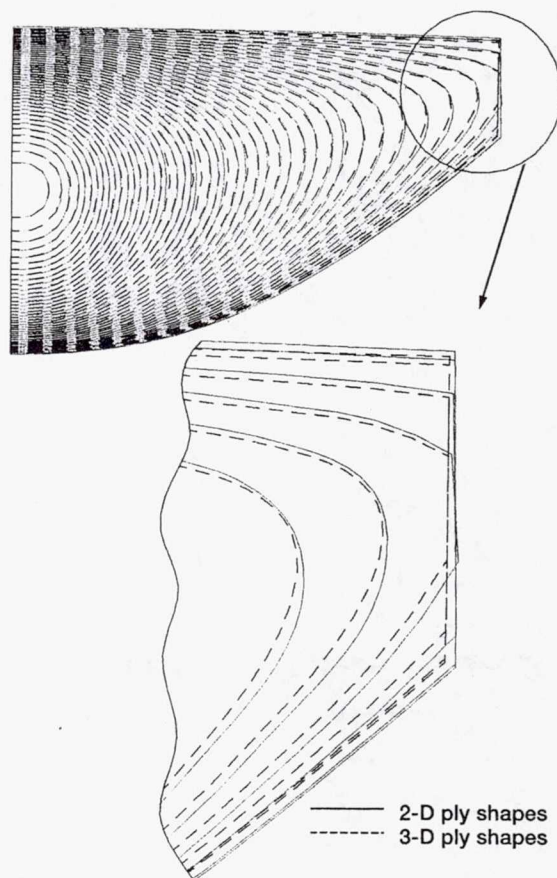


Figure 41.—Comparison of three-dimensional and two-dimensional ply shapes: 3-D and 2-D ply templates stacked up on top of one another.

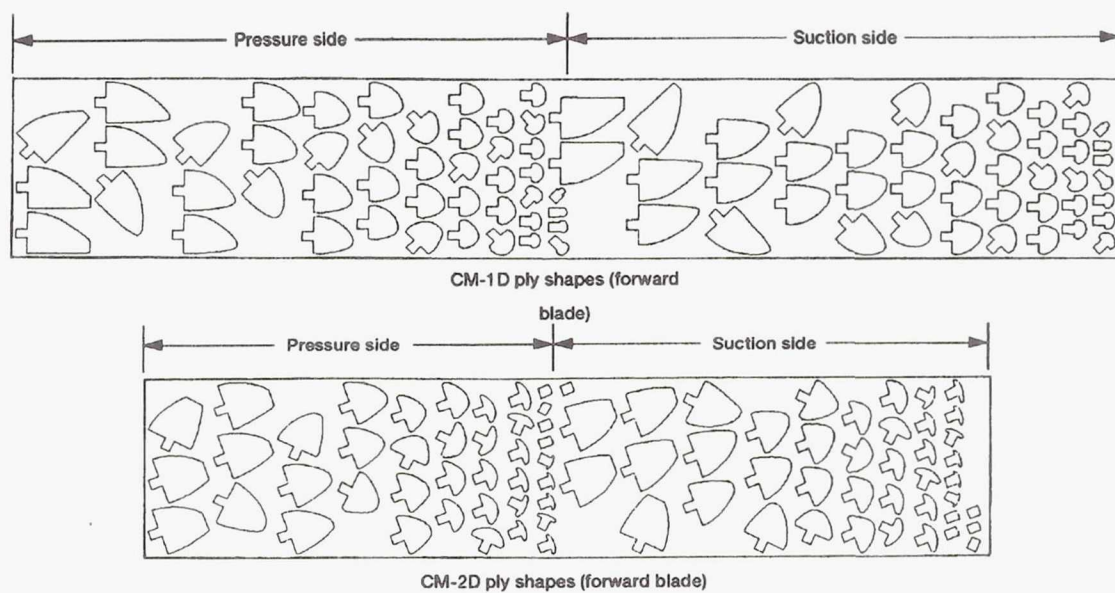


Figure 42.—Nested ply shape on composite material.

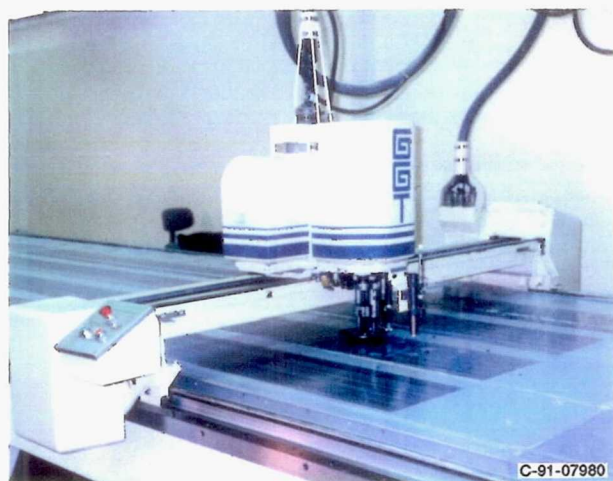


Figure 43.—Pattern cutting machine.

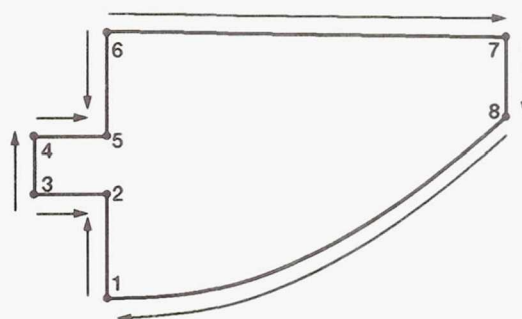


Figure 44.—Cutting sequence.

# APPENDIX A—COLD-SHAPE COORDINATE LISTINGS

The output listings of the blade cold shapes contain the number of cross-sectional cuts, the number of points on each side of the blade (i.e., pressure and suction sides), and the X,Y,Z points that define the blade pressure and suction surfaces. The last column of the listing contains a value that distinguishes whether the coordinate point is used to build the spanwise splines. If the value is 0, the point is used only for the cross-sectional splines. If the value is 1, the point is used for creation of a spanwise spline as well as the cross-sectional spline.

The first line in the output listing contains the number of cross-sectional cuts (NUMCUT) and the number of points on each side of the blade (NUMPTS). The Fortran format output statement for this line is (5X,2I5). The first set of *n* NUMPTS define the pressure side of the first cross section (NUMCUT = 1) of the blade. The second set of *n* NUMPTS define the suction side of the first cross section (NUMCUT = 1) of the blade. This sequence of coordinate descriptions is repeated, thus defining the airfoil surfaces from the base to the tip of the blade. The Fortran format output statement for the X,Y,Z coordinates is (3F10.6).

TABLE A-I. — CM-1D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.124855	-1.198350	-0.673686	0	4.124907	-0.083774	0.148754	0
4.124855	-1.195989	-0.676585	0	4.124883	0.157984	0.279820	1
4.124855	-1.193178	-0.679051	0	4.124674	0.405065	0.401274	0
4.124855	-1.189997	-0.681013	0	4.124415	0.659068	0.510603	1
4.124855	-1.186531	-0.682418	0	4.124246	0.921437	0.605079	0
4.124855	-1.182881	-0.683226	0	4.124207	1.056464	0.645509	0
4.124855	-1.179150	-0.683414	0	4.124096	1.195097	0.678408	0
4.124855	-1.175437	-0.682978	0	4.207389	-1.231034	-0.611949	0
4.124857	-1.155982	-0.679028	0	4.207388	-1.228830	-0.614965	0
4.124864	-1.121431	-0.670308	0	4.207388	-1.226152	-0.617571	0
4.124866	-1.055421	-0.647415	0	4.207387	-1.223078	-0.619694	0
4.124854	-0.991183	-0.621437	0	4.207386	-1.219693	-0.621276	0
4.124855	-0.927842	-0.593809	0	4.207385	-1.216091	-0.622270	0
4.124866	-0.802563	-0.536059	0	4.207385	-1.212374	-0.622651	0
4.124883	-0.678486	-0.476140	1	4.207384	-1.208645	-0.622410	0
4.124906	-0.432833	-0.351982	0	4.207382	-1.188991	-0.619463	0
4.124942	-0.189663	-0.223474	1	4.207381	-1.154055	-0.612513	0
4.124907	0.051214	-0.090803	0	4.207375	-1.086958	-0.593035	0
4.124880	0.289504	0.046421	1	4.207376	-1.021457	-0.570341	0
4.124581	0.524213	0.189844	0	4.207381	-0.956723	-0.546091	0
4.124411	0.754522	0.341213	1	4.207380	-0.828704	-0.494723	0
4.124216	0.979634	0.501804	0	4.207389	-0.701750	-0.441195	1
4.124144	1.090235	0.585578	0	4.207408	-0.450039	-0.329792	0
4.124097	1.199986	0.669731	0	4.207448	-0.200600	-0.213875	1
4.124097	1.199986	0.669731	0	4.207406	0.046688	-0.093592	0
4.124855	-1.198350	-0.673686	0	4.207370	0.291651	0.031340	1
4.124855	-1.200193	-0.670434	0	4.207035	0.533428	0.162568	0
4.124855	-1.201471	-0.666920	0	4.206831	0.771128	0.302033	1
4.124854	-1.202146	-0.663242	0	4.206612	1.004087	0.451029	0
4.124854	-1.202198	-0.659504	0	4.206601	1.118712	0.529234	0
4.124854	-1.201626	-0.655809	0	4.206527	1.232569	0.607760	0
4.124853	-1.200447	-0.652261	0	4.207389	-1.231034	-0.611949	0
4.124853	-1.198696	-0.648958	0	4.207390	-1.232705	-0.608608	0
4.124855	-1.184823	-0.627845	0	4.207391	-1.233796	-0.605033	0
4.124866	-1.161684	-0.598867	0	4.207392	-1.234277	-0.601328	0
4.124869	-1.111481	-0.547917	0	4.207392	-1.234134	-0.597594	0
4.124871	-1.058984	-0.501047	0	4.207393	-1.233368	-0.593934	0
4.124879	-1.005120	-0.456589	0	4.207394	-1.232006	-0.590455	0
4.124879	-0.895139	-0.371709	0	4.207394	-1.230082	-0.587251	0
4.124888	-0.783001	-0.290639	1	4.207396	-1.215161	-0.566897	0
4.124907	-0.554351	-0.136326	0	4.207397	-1.190593	-0.539128	0
4.124949	-0.321148	0.009883	1	4.207430	-1.137773	-0.490853	0



TABLE A-I. — Continued. CM-1D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.207425	-1.082967	-0.446714	0	4.388984	-1.256702	-0.535380	0
4.207416	-1.026913	-0.405081	0	4.388984	-1.253212	-0.536603	0
4.207417	-0.912730	-0.325938	0	4.388984	-1.249566	-0.537226	0
4.207410	-0.796620	-0.250694	1	4.388984	-1.245868	-0.537233	0
4.207420	-0.560390	-0.108254	0	4.388983	-1.225934	-0.535585	0
4.207447	-0.320073	0.025908	1	4.388983	-1.190653	-0.531002	0
4.207405	-0.075942	0.152517	0	4.388978	-1.122499	-0.516042	0
4.207376	0.172167	0.271128	1	4.388967	-1.055664	-0.497912	0
4.207080	0.425131	0.379824	0	4.388956	-0.989516	-0.478124	0
4.206908	0.684319	0.476189	1	4.388946	-0.858443	-0.435622	0
4.206702	0.951151	0.557228	0	4.388936	-0.728291	-0.390901	1
4.206619	1.088067	0.590733	0	4.388925	-0.469862	-0.296987	0
4.206532	1.228124	0.616680	0	4.388923	-0.213353	-0.198465	1
4.289948	-1.252936	-0.564022	0	4.388874	0.041322	-0.095501	0
4.289947	-1.250855	-0.567115	0	4.388790	0.294031	0.012230	1
4.289946	-1.248287	-0.569818	0	4.388484	0.544037	0.126415	0
4.289945	-1.245305	-0.572056	0	4.388266	0.790519	0.249036	1
4.289945	-1.241991	-0.573763	0	4.388004	1.032944	0.381417	0
4.289944	-1.238440	-0.574895	0	4.387901	1.152619	0.451312	0
4.289944	-1.234748	-0.575419	0	4.387809	1.271477	0.521739	0
4.289944	-1.231021	-0.575318	0	4.388984	-1.267265	-0.525397	0
4.289942	-1.211226	-0.573125	0	4.388985	-1.268682	-0.521982	0
4.289938	-1.176057	-0.567525	0	4.388985	-1.269511	-0.518378	0
4.289937	-1.108268	-0.550641	0	4.388985	-1.269724	-0.514685	0
4.289931	-1.041972	-0.530480	0	4.388985	-1.269317	-0.511009	0
4.289919	-0.976385	-0.508741	0	4.388985	-1.268300	-0.507453	0
4.289918	-0.846512	-0.462344	0	4.388985	-1.266705	-0.504117	0
4.289909	-0.717646	-0.413739	1	4.388985	-1.264573	-0.501094	0
4.289921	-0.461900	-0.312115	0	4.388985	-1.248226	-0.481931	0
4.289939	-0.208263	-0.205885	1	4.388984	-1.221778	-0.456091	0
4.289887	0.043405	-0.095225	0	4.388980	-1.165857	-0.411699	0
4.289846	0.292924	0.020183	1	4.388968	-1.108110	-0.371698	0
4.289521	0.539499	0.142017	0	4.388957	-1.049335	-0.334164	0
4.289309	0.782330	0.272210	1	4.388947	-0.930048	-0.263306	0
4.289074	1.020790	0.412099	0	4.388937	-0.809108	-0.196419	1
4.288967	1.138364	0.485708	0	4.388925	-0.563851	-0.070812	0
4.288880	1.255120	0.559804	0	4.388923	-0.315076	0.046319	1
4.289948	-1.252936	-0.564022	0	4.388873	-0.063090	0.155753	0
4.289948	-1.254472	-0.560625	0	4.388791	0.192297	0.257034	1
4.289948	-1.255421	-0.557019	0	4.388485	0.451893	0.348141	0
4.289949	-1.255754	-0.553306	0	4.388267	0.716667	0.426740	1
4.289950	-1.255463	-0.549588	0	4.388008	0.987916	0.489762	0
4.289950	-1.254556	-0.545971	0	4.387905	1.126500	0.514159	0
4.289951	-1.253060	-0.542555	0	4.387809	1.267651	0.530940	0
4.289952	-1.251017	-0.539437	0	4.504506	-1.270586	-0.504754	0
4.289953	-1.235308	-0.519714	0	4.504506	-1.268699	-0.507856	0
4.289949	-1.209682	-0.492965	0	4.504506	-1.266317	-0.510597	0
4.289944	-1.155114	-0.446792	0	4.504506	-1.263510	-0.512898	0
4.289941	-1.098627	-0.404873	0	4.504506	-1.260354	-0.514694	0
4.289929	-1.041011	-0.365467	0	4.504506	-1.256942	-0.515934	0
4.289926	-0.923875	-0.290854	0	4.504506	-1.253369	-0.516583	0
4.289918	-0.804927	-0.220258	1	4.504506	-1.249739	-0.516624	0
4.289922	-0.563460	-0.087027	0	4.504505	-1.229636	-0.515141	0
4.289937	-0.318176	0.037710	0	4.504503	-1.194424	-0.510919	0
4.289887	-0.069411	0.154799	0	4.504491	-1.126231	-0.496847	0
4.289850	0.183003	0.263784	1	4.504485	-1.059339	-0.479525	0
4.289533	0.439930	0.362654	0	4.504470	-0.993071	-0.460632	0
4.289328	0.702532	0.449035	1	4.504458	-0.861676	-0.419969	0
4.289096	0.972153	0.519883	0	4.504444	-0.731156	-0.377117	1
4.288981	1.110165	0.548196	0	4.504429	-0.471875	-0.287020	0
4.288886	1.251020	0.568887	0	4.504413	-0.214395	-0.192395	1
4.388984	-1.267265	-0.525397	0	4.504356	0.041361	-0.093406	0
4.388984	-1.265296	-0.528527	0	4.504267	0.295256	0.010285	1
4.388984	-1.262830	-0.531284	0	4.503963	0.546626	0.120307	0
4.388984	-1.259939	-0.533589	0	4.503736	0.794653	0.238656	1

TABLE A-I. — Continued. CM-1D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.503471	1.038839	0.366637	0	4.636452	-0.801040	-0.180748	1
4.503361	1.159483	0.434276	0	4.636426	-0.553897	-0.062050	0
4.503261	1.279335	0.502423	0	4.636397	-0.303569	0.048487	1
4.504506	-1.270586	-0.504754	0	4.636338	-0.050347	0.151622	0
4.504507	-1.271923	-0.501379	0	4.636222	0.205962	0.246899	1
4.504507	-1.272675	-0.497827	0	4.635938	0.466070	0.332420	0
4.504507	-1.272818	-0.494199	0	4.635719	0.730793	0.405995	1
4.504507	-1.272348	-0.490600	0	4.635448	1.001329	0.464633	0
4.504507	-1.271282	-0.487129	0	4.635341	1.139254	0.487145	0
4.504507	-1.269645	-0.483889	0	4.635243	1.279449	0.502328	0
4.504507	-1.267489	-0.480968	0	4.785032	-1.254960	-0.483535	0
4.504506	-1.250719	-0.462176	0	4.785032	-1.253270	-0.486372	0
4.504504	-1.223859	-0.436977	0	4.785032	-1.251118	-0.488875	0
4.504491	-1.167230	-0.393861	0	4.785032	-1.248564	-0.490968	0
4.504486	-1.108930	-0.354954	0	4.785032	-1.245687	-0.492589	0
4.504471	-1.049635	-0.318540	0	4.785030	-1.242553	-0.493726	0
4.504459	-0.929387	-0.249883	0	4.785030	-1.239297	-0.494271	0
4.504441	-0.807553	-0.185214	1	4.785030	-1.235995	-0.494247	0
4.504429	-0.560760	-0.063754	0	4.785029	-1.215197	-0.492290	0
4.504413	-0.310598	0.049250	1	4.785025	-1.180530	-0.487676	0
4.504356	-0.057389	0.154638	0	4.785017	-1.113202	-0.473252	0
4.504268	0.199029	0.251986	1	4.785002	-1.046969	-0.456002	0
4.503965	0.459457	0.339251	0	4.784986	-0.981300	-0.437287	0
4.503741	0.724772	0.414175	1	4.784970	-0.850955	-0.397286	0
4.503474	0.996205	0.473717	0	4.784952	-0.721361	-0.355344	1
4.503364	1.134721	0.496463	0	4.784918	-0.463682	-0.267542	0
4.503262	1.275648	0.511679	0	4.784869	-0.207519	-0.175785	1
4.636519	-1.266208	-0.492674	0	4.784801	0.047153	-0.080147	0
4.636518	-1.264407	-0.495680	0	4.784672	0.300248	0.019631	1
4.636518	-1.262122	-0.498337	0	4.784405	0.551141	0.125116	0
4.636518	-1.259419	-0.500567	0	4.784193	0.799078	0.238136	1
4.636518	-1.256377	-0.502306	0	4.783934	1.043665	0.359809	0
4.636518	-1.253083	-0.503502	0	4.783826	1.164699	0.423901	0
4.636518	-1.249635	-0.504121	0	4.783706	1.284994	0.488340	0
4.636518	-1.246131	-0.504149	0	4.785032	-1.254960	-0.483535	0
4.636518	-1.225759	-0.502547	0	4.785032	-1.256133	-0.480449	0
4.636517	-1.190744	-0.498278	0	4.785032	-1.256756	-0.477206	0
4.636511	-1.122866	-0.484232	0	4.785033	-1.256809	-0.473905	0
4.636497	-1.056148	-0.467197	0	4.785033	-1.256291	-0.470644	0
4.636481	-0.990046	-0.448587	0	4.785030	-1.255200	-0.467553	0
4.636467	-0.858926	-0.408591	0	4.785030	-1.253605	-0.464663	0
4.636452	-0.728631	-0.366491	1	4.785030	-1.251535	-0.462090	0
4.636426	-0.469676	-0.278093	0	4.785029	-1.233864	-0.443923	0
4.636397	-0.212406	-0.185365	1	4.785025	-1.206589	-0.420152	0
4.636338	0.043243	-0.088455	0	4.785016	-1.149494	-0.379216	0
4.636221	0.297173	0.012928	1	4.785002	-1.090872	-0.342246	0
4.635937	0.548713	0.120427	0	4.784986	-1.031379	-0.307524	0
4.635718	0.797074	0.235973	1	4.784970	-0.910909	-0.241938	0
4.635447	1.041821	0.360771	0	4.784951	-0.789038	-0.179981	1
4.635340	1.162823	0.426686	0	4.784918	-0.542415	-0.063536	0
4.635243	1.283068	0.493046	0	4.784869	-0.292758	0.045080	1
4.636519	-1.266208	-0.492674	0	4.784801	-0.040372	0.146641	0
4.636519	-1.267470	-0.489405	0	4.784673	0.214926	0.240711	1
4.636518	-1.268159	-0.485970	0	4.784405	0.473801	0.325511	0
4.636518	-1.268254	-0.482468	0	4.784194	0.737000	0.398991	1
4.636518	-1.267753	-0.479000	0	4.783936	1.005659	0.458287	0
4.636518	-1.266669	-0.475668	0	4.783828	1.142488	0.481453	0
4.636518	-1.265034	-0.472569	0	4.783708	1.281407	0.497636	0
4.636518	-1.262897	-0.469792	0	4.950028	-1.235655	-0.476130	0
4.636518	-1.245731	-0.451306	0	4.950028	-1.234102	-0.478729	0
4.636517	-1.218631	-0.426744	0	4.950028	-1.232117	-0.481013	0
4.636511	-1.161705	-0.384599	0	4.950028	-1.229759	-0.482913	0
4.636497	-1.103128	-0.346682	0	4.950028	-1.227104	-0.484367	0
4.636481	-1.043634	-0.311116	0	4.950028	-1.224235	-0.485329	0
4.636467	-0.923077	-0.244032	0	4.950028	-1.221239	-0.485772	0



TABLE A-I. — Continued. CM-1D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.950028	-1.218214	-0.485682	0	5.115023	-1.209544	-0.470361	0
4.950028	-1.196853	-0.483123	0	5.115023	-1.210519	-0.467786	0
4.950026	-1.162724	-0.477846	0	5.115023	-1.211015	-0.465079	0
4.950008	-1.096253	-0.462647	0	5.115023	-1.211016	-0.462326	0
4.950003	-1.030803	-0.444802	0	5.115023	-1.210523	-0.459618	0
4.949986	-0.965842	-0.425687	0	5.115023	-1.209551	-0.457042	0
4.949969	-0.836819	-0.385135	0	5.115023	-1.208132	-0.454684	0
4.949943	-0.708440	-0.342905	1	5.115023	-1.206312	-0.452619	0
4.949911	-0.453091	-0.254800	0	5.115022	-1.187516	-0.434967	0
4.949854	-0.199050	-0.163257	1	5.115021	-1.160254	-0.412892	0
4.949780	0.053660	-0.068246	0	5.115001	-1.103445	-0.374556	0
4.949647	0.304953	0.030475	1	5.114997	-1.045402	-0.339448	0
4.949392	0.554277	0.134314	0	5.114981	-0.986610	-0.306289	0
4.949187	0.800930	0.244971	1	5.114960	-0.867629	-0.243450	0
4.948930	1.044560	0.363421	0	5.114928	-0.747426	-0.183774	1
4.948826	1.165254	0.425551	0	5.114892	-0.504582	-0.070714	0
4.948726	1.285337	0.487773	0	5.114833	-0.259090	0.035534	1
4.950028	-1.235655	-0.476130	0	5.114745	-0.011089	0.135480	0
4.950028	-1.236724	-0.473298	0	5.114602	0.239384	0.229039	1
4.950028	-1.237277	-0.470322	0	5.114370	0.492958	0.314619	0
4.950028	-1.237297	-0.467295	0	5.114182	0.750279	0.390491	1
4.950028	-1.236784	-0.464313	0	5.113934	1.012325	0.454165	0
4.950028	-1.235752	-0.461468	0	5.113838	1.145532	0.480392	0
4.950028	-1.234234	-0.458848	0	5.113748	1.280571	0.500409	0
4.950028	-1.232280	-0.456539	0	5.280011	-1.176460	-0.465966	0
4.950027	-1.214006	-0.438654	0	5.280011	-1.175159	-0.468089	0
4.950025	-1.186675	-0.415757	0	5.280011	-1.173491	-0.469940	0
4.950008	-1.129609	-0.376178	0	5.280011	-1.171514	-0.471454	0
4.950002	-1.071154	-0.340198	0	5.280011	-1.169292	-0.472582	0
4.949985	-1.011876	-0.306347	0	5.280011	-1.166903	-0.473285	0
4.949968	-0.891937	-0.242247	0	5.280011	-1.164425	-0.473540	0
4.949942	-0.770668	-0.181589	1	5.280011	-1.161943	-0.473337	0
4.949911	-0.525501	-0.067087	0	5.280009	-1.139629	-0.469434	0
4.949854	-0.277465	0.040024	1	5.280006	-1.106772	-0.462750	0
4.949780	-0.026885	0.140553	0	5.280001	-1.042582	-0.445540	0
4.949648	0.226401	0.234109	1	5.279985	-0.979183	-0.426322	0
4.949392	0.483027	0.319017	0	5.279966	-0.916195	-0.406061	0
4.949188	0.743669	0.393409	1	5.279947	-0.790962	-0.363685	0
4.948932	1.009383	0.454613	0	5.279925	-0.666258	-0.319966	1
4.948828	1.144572	0.479164	0	5.279874	-0.417870	-0.229920	0
4.948726	1.281750	0.497072	0	5.279799	-0.170520	-0.137220	1
5.115023	-1.209544	-0.470361	0	5.279718	0.075758	-0.041823	0
5.115023	-1.208122	-0.472718	0	5.279576	0.320936	0.056397	1
5.115023	-1.206301	-0.474782	0	5.279353	0.564497	0.158690	0
5.115023	-1.204138	-0.476484	0	5.279174	0.805849	0.266467	1
5.115023	-1.201703	-0.477772	0	5.278943	1.044755	0.380384	0
5.115023	-1.199078	-0.478600	0	5.278847	1.163317	0.439582	0
5.115023	-1.196347	-0.478944	0	5.278763	1.281413	0.498517	0
5.115023	-1.193598	-0.478791	0	5.280011	-1.176460	-0.465966	0
5.115022	-1.171713	-0.475578	0	5.280011	-1.177351	-0.463640	0
5.115021	-1.138187	-0.469599	0	5.280011	-1.177802	-0.461191	0
5.115001	-1.072713	-0.453531	0	5.280011	-1.177798	-0.458701	0
5.114997	-1.008222	-0.434994	0	5.280011	-1.177340	-0.456253	0
5.114981	-0.944189	-0.415301	0	5.280011	-1.176441	-0.453932	0
5.114960	-0.816829	-0.373996	0	5.280011	-1.175134	-0.451812	0
5.114929	-0.690064	-0.331183	1	5.280011	-1.173460	-0.449969	0
5.114892	-0.437813	-0.242294	0	5.280009	-1.154260	-0.432503	0
5.114833	-0.186761	-0.150336	1	5.280006	-1.127204	-0.411170	0
5.114744	0.063230	-0.055503	0	5.280001	-1.071039	-0.373703	0
5.114602	0.311898	0.042690	1	5.279985	-1.013613	-0.339403	0
5.114370	0.558779	0.145467	0	5.279966	-0.955484	-0.306879	0
5.114182	0.803252	0.254361	1	5.279947	-0.838019	-0.244886	0
5.113932	1.044994	0.370208	0	5.279925	-0.719404	-0.185798	1
5.113837	1.164868	0.430695	0	5.279874	-0.479753	-0.073695	0
5.113748	1.284184	0.491123	0	5.279799	-0.237581	0.032076	1



TABLE A-I. — Continued. CM-1D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
5.279718	0.006825	0.132202	0	5.774890	-0.909781	-0.421032	0
5.279576	0.253640	0.226290	1	5.774886	-0.850979	-0.399347	0
5.279352	0.503363	0.313029	0	5.774879	-0.792487	-0.376957	0
5.279176	0.756570	0.390876	1	5.774849	-0.675899	-0.331205	0
5.278945	1.014233	0.457447	0	5.774815	-0.559683	-0.284602	1
5.278848	1.145113	0.485539	0	5.774772	-0.328106	-0.189465	0
5.278764	1.277743	0.507781	0	5.774708	-0.097268	-0.092640	1
5.527478	-1.113425	-0.460177	0	5.774601	0.133032	0.005527	0
5.527478	-1.112282	-0.461976	0	5.774506	0.362337	0.105893	1
5.527478	-1.110823	-0.463531	0	5.774394	0.590425	0.209037	0
5.527478	-1.109099	-0.464785	0	5.774217	0.816973	0.315720	1
5.527478	-1.107173	-0.465696	0	5.774036	1.041635	0.426680	0
5.527478	-1.105108	-0.466232	0	5.773966	1.153345	0.483580	0
5.527478	-1.102982	-0.466372	0	5.773898	1.264804	0.539790	0
5.527478	-1.100865	-0.466115	0	5.774920	-1.033141	-0.451152	0
5.527476	-1.078174	-0.461139	0	5.774920	-1.033838	-0.449479	0
5.527474	-1.046485	-0.453375	0	5.774920	-1.034204	-0.447705	0
5.527448	-0.984359	-0.434781	0	5.774920	-1.034225	-0.445893	0
5.527446	-0.923053	-0.414246	0	5.774920	-1.033903	-0.444112	0
5.527433	-0.862096	-0.392878	0	5.774920	-1.033247	-0.442423	0
5.527406	-0.740690	-0.348830	0	5.774920	-1.032281	-0.440891	0
5.527393	-0.619841	-0.303505	1	5.774920	-1.031044	-0.439569	0
5.527327	-0.378783	-0.211134	0	5.774919	-1.011533	-0.422497	0
5.527256	-0.138730	-0.116409	1	5.774919	-0.985966	-0.402861	0
5.527177	0.100471	-0.019591	0	5.774890	-0.932973	-0.367801	0
5.527031	0.338858	0.079312	1	5.774887	-0.879052	-0.334914	0
5.526840	0.575647	0.181928	0	5.774880	-0.824536	-0.303397	0
5.526683	0.810599	0.288980	1	5.774850	-0.714312	-0.243033	0
5.526474	1.043461	0.401083	0	5.774815	-0.603093	-0.184961	1
5.526387	1.159140	0.458939	0	5.774773	-0.378721	-0.073287	0
5.526315	1.274483	0.516269	0	5.774708	-0.152191	0.033426	1
5.527478	-1.113425	-0.460177	0	5.774601	0.076491	0.135311	0
5.527478	-1.114211	-0.458195	0	5.774506	0.307027	0.232851	1
5.527478	-1.114614	-0.456101	0	5.774394	0.540025	0.324728	0
5.527478	-1.114618	-0.453971	0	5.774217	0.776110	0.409517	1
5.527478	-1.114224	-0.451877	0	5.774038	1.015919	0.485709	0
5.527478	-1.113446	-0.449892	0	5.773967	1.137595	0.519733	0
5.527478	-1.112310	-0.448089	0	5.773899	1.260824	0.548924	0
5.527478	-1.110861	-0.446528	0	5.981100	-0.953474	-0.437083	0
5.527477	-1.091337	-0.429261	0	5.981100	-0.952581	-0.438377	0
5.527475	-1.064876	-0.408841	0	5.981100	-0.951454	-0.439473	0
5.527448	-1.009975	-0.372744	0	5.981099	-0.950139	-0.440333	0
5.527446	-0.954054	-0.339172	0	5.981099	-0.948681	-0.440925	0
5.527434	-0.897477	-0.307196	0	5.981099	-0.947138	-0.441223	0
5.527407	-0.783083	-0.246167	0	5.981099	-0.945565	-0.441219	0
5.527393	-0.667733	-0.187524	1	5.981099	-0.944024	-0.440913	0
5.527327	-0.434582	-0.076007	0	5.981097	-0.921546	-0.434116	0
5.527256	-0.199233	0.030111	1	5.981095	-0.892545	-0.424671	0
5.527177	0.038234	0.131131	0	5.981066	-0.835477	-0.403699	0
5.527031	0.278045	0.226590	1	5.981064	-0.779102	-0.381243	0
5.526840	0.520325	0.315910	0	5.981063	-0.723000	-0.358192	0
5.526684	0.765885	0.397272	1	5.981032	-0.611092	-0.311398	0
5.526475	1.015560	0.468655	0	5.981002	-0.499497	-0.263910	1
5.526389	1.142293	0.499743	0	5.980966	-0.277084	-0.167282	0
5.526316	1.270679	0.525481	0	5.980910	-0.055297	-0.069284	1
5.774920	-1.033141	-0.451152	0	5.980848	0.165884	0.030044	0
5.774920	-1.032139	-0.452661	0	5.980742	0.386565	0.130552	1
5.774920	-1.030867	-0.453952	0	5.980603	0.605917	0.233850	0
5.774920	-1.029373	-0.454978	0	5.980505	0.824032	0.339919	1
5.774920	-1.027711	-0.455701	0	5.980347	1.040425	0.449685	0
5.774920	-1.025943	-0.456097	0	5.980285	1.148102	0.505706	0
5.774920	-1.024131	-0.456147	0	5.980224	1.255610	0.560912	0
5.774920	-1.022343	-0.455854	0	5.981100	-0.953474	-0.437083	0
5.774919	-0.999624	-0.449836	0	5.981100	-0.954102	-0.435642	0
5.774918	-0.969318	-0.441070	0	5.981100	-0.954440	-0.434108	0

TABLE A-I. — Continued. CM-1D FORWARD COLD SHAPE COORDINATES  
 [Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
5.981100	-0.954476	-0.432537	0	6.186783	0.798109	0.438163	1
5.981100	-0.954208	-0.430988	0	6.186671	1.017745	0.519655	0
5.981100	-0.953647	-0.429521	0	6.186618	1.129043	0.557277	0
5.981100	-0.952813	-0.428190	0	6.186561	1.241759	0.590830	0
5.981099	-0.951737	-0.427045	0	6.393422	-0.761962	-0.383796	0
5.981097	-0.932460	-0.410206	0	6.393422	-0.761267	-0.384726	0
5.981096	-0.907805	-0.391244	0	6.393422	-0.760404	-0.385503	0
5.981067	-0.856743	-0.357116	0	6.393422	-0.759404	-0.386094	0
5.981065	-0.804849	-0.324845	0	6.393422	-0.758307	-0.386478	0
5.981065	-0.752400	-0.293791	0	6.393422	-0.757158	-0.386639	0
5.981033	-0.646345	-0.234174	0	6.393422	-0.755999	-0.386569	0
5.981003	-0.539352	-0.176608	1	6.393421	-0.754876	-0.386273	0
5.980966	-0.323584	-0.065419	0	6.393419	-0.733580	-0.378332	0
5.980910	-0.105792	0.041330	1	6.393416	-0.707570	-0.368069	0
5.980848	0.113857	0.144014	0	6.393391	-0.656195	-0.346224	0
5.980742	0.335618	0.242155	1	6.393390	-0.605458	-0.323123	0
5.980651	0.559470	0.335622	0	6.393406	-0.554931	-0.299579	0
5.980505	0.786216	0.422761	1	6.393380	-0.453951	-0.252360	0
5.980349	1.016433	0.502246	0	6.393388	-0.353438	-0.204220	1
5.980286	1.133209	0.538331	0	6.393353	-0.152324	-0.108063	0
5.980225	1.251473	0.569977	0	6.393333	0.048094	-0.010538	1
6.187265	-0.862781	-0.415005	0	6.393299	0.248150	0.087701	0
6.187265	-0.861991	-0.416106	0	6.393246	0.447939	0.186516	1
6.187265	-0.861001	-0.417032	0	6.393160	0.646566	0.287600	0
6.187265	-0.859850	-0.417747	0	6.393088	0.844228	0.390619	1
6.187265	-0.858582	-0.418224	0	6.392982	1.040714	0.496000	0
6.187265	-0.857244	-0.418445	0	6.392928	1.138633	0.549336	0
6.187264	-0.855890	-0.418401	0	6.392884	1.236557	0.601667	0
6.187264	-0.854570	-0.418097	0	6.393422	-0.761962	-0.383796	0
6.187263	-0.832571	-0.410644	0	6.393422	-0.762458	-0.382746	0
6.187261	-0.805009	-0.400689	0	6.393422	-0.762738	-0.381620	0
6.187233	-0.750679	-0.379089	0	6.393422	-0.762790	-0.380462	0
6.187232	-0.697005	-0.356144	0	6.393422	-0.762613	-0.379316	0
6.187238	-0.643568	-0.332694	0	6.393422	-0.762213	-0.378227	0
6.187209	-0.536889	-0.285369	0	6.393422	-0.761607	-0.377239	0
6.187184	-0.430471	-0.237488	1	6.393422	-0.760817	-0.376391	0
6.187158	-0.218344	-0.140290	0	6.393419	-0.742544	-0.360343	0
6.187118	-0.006745	-0.041986	1	6.393417	-0.720114	-0.342897	0
6.187071	0.204369	0.057331	0	6.393392	-0.673691	-0.311114	0
6.186987	0.415101	0.157506	1	6.393391	-0.626651	-0.280593	0
6.186876	0.624596	0.260174	0	6.393407	-0.579148	-0.250983	0
6.186782	0.832921	0.365294	1	6.393381	-0.483019	-0.194026	0
6.186669	1.040042	0.472981	0	6.393389	-0.386336	-0.138204	1
6.186617	1.143093	0.527867	0	6.393353	-0.190771	-0.030909	0
6.186561	1.246056	0.581838	0	6.393333	0.006266	0.073400	1
6.187265	-0.862781	-0.415005	0	6.393299	0.204959	0.174375	0
6.187265	-0.863342	-0.413772	0	6.393247	0.405535	0.271612	1
6.187265	-0.863651	-0.412454	0	6.393160	0.607699	0.365598	0
6.187265	-0.863697	-0.411101	0	6.393090	0.812375	0.454539	1
6.187265	-0.863478	-0.409765	0	6.393004	1.020282	0.537038	0
6.187265	-0.863003	-0.408498	0	6.392929	1.125419	0.575854	0
6.187265	-0.862289	-0.407347	0	6.392885	1.232112	0.610587	0
6.187265	-0.861364	-0.406360	0	6.599569	-0.651631	-0.343764	0
6.187263	-0.842503	-0.389855	0	6.599569	-0.651021	-0.344556	0
6.187262	-0.818901	-0.371612	0	6.599569	-0.650264	-0.345210	0
6.187234	-0.770044	-0.338555	0	6.599569	-0.649393	-0.345701	0
6.187233	-0.720457	-0.307055	0	6.599569	-0.648443	-0.346011	0
6.187239	-0.670355	-0.276625	0	6.599569	-0.647449	-0.346124	0
6.187210	-0.569026	-0.218102	0	6.599569	-0.646452	-0.346039	0
6.187185	-0.466818	-0.161410	1	6.599569	-0.645493	-0.345760	0
6.187159	-0.260786	-0.051452	0	6.599567	-0.625148	-0.337518	0
6.187118	-0.052873	0.054565	1	6.599566	-0.600793	-0.327133	0
6.187071	0.156794	0.156913	0	6.599566	-0.552844	-0.304897	0
6.186988	0.368458	0.255138	1	6.599543	-0.504996	-0.282454	0
6.186918	0.582024	0.349307	0	6.599568	-0.457617	-0.259090	0



TABLE A-I. — Continued. CM-1D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
6.599548	-0.362772	-0.212573	0	6.805713	-0.532649	-0.289616	0
6.599566	-0.268421	-0.165102	1	6.805713	-0.531975	-0.288872	0
6.599553	-0.079445	-0.070669	0	6.805711	-0.515902	-0.274435	0
6.599557	0.108842	0.025075	1	6.805711	-0.496143	-0.258818	0
6.599542	0.296893	0.121262	0	6.805712	-0.455535	-0.229602	0
6.599521	0.484783	0.217777	1	6.805720	-0.414116	-0.201871	0
6.599461	0.671561	0.316402	0	6.805732	-0.372324	-0.174832	0
6.599411	0.857581	0.416484	1	6.805740	-0.288093	-0.121976	0
6.599324	1.042591	0.518517	0	6.805754	-0.203202	-0.070346	1
6.599276	1.134859	0.569993	0	6.805765	-0.031670	0.029667	0
6.599241	1.227193	0.620424	0	6.805796	0.140869	0.127821	1
6.599569	-0.651631	-0.343764	0	6.805803	0.314899	0.223189	0
6.599570	-0.652072	-0.342868	0	6.805800	0.490263	0.316077	1
6.599570	-0.652326	-0.341902	0	6.805782	0.667347	0.405788	0
6.599569	-0.652382	-0.340906	0	6.805755	0.846320	0.491982	1
6.599569	-0.652240	-0.339918	0	6.805690	1.027783	0.573565	0
6.599569	-0.651903	-0.338980	0	6.805649	1.119770	0.612034	0
6.599569	-0.651386	-0.338126	0	6.805620	1.212962	0.647422	0
6.599569	-0.650709	-0.337393	0	7.011857	-0.407621	-0.238870	0
6.599567	-0.633228	-0.321939	0	7.011857	-0.406978	-0.239649	0
6.599566	-0.612089	-0.305355	0	7.011857	-0.406193	-0.240283	0
6.599566	-0.568589	-0.274541	0	7.011857	-0.405296	-0.240748	0
6.599544	-0.524069	-0.245683	0	7.011857	-0.404324	-0.241024	0
6.599569	-0.479410	-0.217075	0	7.011857	-0.403317	-0.241100	0
6.599548	-0.388941	-0.162121	0	7.011857	-0.402315	-0.240974	0
6.599567	-0.298049	-0.107982	1	7.011857	-0.401360	-0.240648	0
6.599553	-0.114098	-0.003862	0	7.011857	-0.384492	-0.232944	0
6.599557	0.071102	0.097832	1	7.011859	-0.363720	-0.222776	0
6.599542	0.257874	0.196483	0	7.011863	-0.322742	-0.201425	0
6.599522	0.446418	0.291741	1	7.011884	-0.281876	-0.179856	0
6.599462	0.636304	0.384372	0	7.011907	-0.241174	-0.157992	0
6.599413	0.828553	0.472450	1	7.011929	-0.159975	-0.113928	0
6.599325	1.023564	0.555201	0	7.011950	-0.078920	-0.069611	1
6.599277	1.122443	0.593931	0	7.012008	0.083153	0.019098	0
6.599242	1.222607	0.629268	0	7.012056	0.244998	0.108204	1
6.805713	-0.532824	-0.295280	0	7.012089	0.406620	0.197701	0
6.805713	-0.532196	-0.296066	0	7.012114	0.567948	0.287719	1
6.805713	-0.531426	-0.296710	0	7.012130	0.728894	0.378432	0
6.805713	-0.530541	-0.297189	0	7.012121	0.889169	0.470331	1
6.805713	-0.529579	-0.297482	0	7.012083	1.048758	0.563471	0
6.805713	-0.528577	-0.297576	0	7.012053	1.128453	0.610220	0
6.805713	-0.527578	-0.297470	0	7.012030	1.208323	0.655896	0
6.805713	-0.526621	-0.297166	0	7.011857	-0.407621	-0.238870	0
6.805711	-0.507982	-0.289122	0	7.011857	-0.408093	-0.237980	0
6.805710	-0.485389	-0.278758	0	7.011857	-0.408377	-0.237014	0
6.805711	-0.440863	-0.256807	0	7.011857	-0.408461	-0.236010	0
6.805719	-0.396518	-0.234505	0	7.011857	-0.408341	-0.235011	0
6.805731	-0.352331	-0.211905	0	7.011857	-0.408021	-0.234056	0
6.805740	-0.264252	-0.166185	0	7.011857	-0.407516	-0.233185	0
6.805753	-0.176318	-0.120196	1	7.011857	-0.406847	-0.232434	0
6.805765	-0.000378	-0.028359	0	7.011857	-0.392241	-0.219098	0
6.805796	0.174873	0.064767	1	7.011859	-0.373950	-0.204499	0
6.805803	0.350020	0.158064	0	7.011863	-0.336398	-0.177026	0
6.805799	0.524804	0.252027	1	7.011884	-0.298091	-0.150885	0
6.805781	0.699128	0.346857	0	7.011907	-0.259483	-0.125280	0
6.805753	0.872608	0.443238	1	7.011929	-0.181645	-0.075211	0
6.805688	1.045248	0.541183	0	7.011950	-0.103249	-0.026141	1
6.805648	1.131405	0.590458	0	7.012008	0.054971	0.069451	0
6.805619	1.217690	0.638656	0	7.012057	0.214457	0.162772	1
6.805713	-0.532824	-0.295280	0	7.012089	0.375109	0.254001	0
6.805713	-0.533281	-0.294386	0	7.012114	0.536956	0.343094	1
6.805713	-0.533549	-0.293420	0	7.012132	0.700326	0.429474	0
6.805713	-0.533620	-0.292420	0	7.012124	0.865418	0.512769	1
6.805713	-0.533488	-0.291425	0	7.012086	1.032738	0.592094	0
6.805713	-0.533160	-0.290478	0	7.012053	1.117537	0.629724	0



TABLE A-I. — Continued. CM-1D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
7.012032	1.203460	0.664582	0	7.424649	0.396089	0.206992	1
7.218020	-0.276607	-0.174668	0	7.424760	0.529354	0.285575	0
7.218020	-0.275951	-0.175439	0	7.424821	0.661832	0.365551	1
7.218020	-0.275152	-0.176062	0	7.424875	0.794321	0.445462	0
7.218020	-0.274244	-0.176514	0	7.424913	0.926425	0.526028	1
7.218020	-0.273264	-0.176773	0	7.424931	1.058091	0.607334	0
7.218021	-0.272251	-0.176832	0	7.424927	1.123950	0.647938	0
7.218021	-0.271248	-0.176687	0	7.424961	1.190259	0.687158	0
7.218021	-0.270295	-0.176344	0	7.424249	-0.140155	-0.102206	0
7.218024	-0.255253	-0.169121	0	7.424249	-0.140655	-0.101324	0
7.218029	-0.236345	-0.159322	0	7.424249	-0.140967	-0.100360	0
7.218080	-0.199222	-0.138479	0	7.424250	-0.141076	-0.099353	0
7.218073	-0.161762	-0.118306	0	7.424250	-0.140979	-0.098345	0
7.218081	-0.124732	-0.097356	0	7.424251	-0.140680	-0.097377	0
7.218151	-0.050962	-0.054901	0	7.424251	-0.140191	-0.096490	0
7.218177	0.023308	-0.013393	1	7.424252	-0.139532	-0.095719	0
7.218266	0.170847	0.071450	0	7.424261	-0.128051	-0.084813	0
7.218352	0.318870	0.155393	1	7.424273	-0.112923	-0.072429	0
7.218406	0.466415	0.240180	0	7.424291	-0.081914	-0.048923	0
7.218444	0.613455	0.325870	1	7.424303	-0.050443	-0.026190	0
7.218472	0.760427	0.411647	0	7.424318	-0.018306	-0.004612	0
7.218524	0.907198	0.497748	1	7.424399	0.045526	0.039431	0
7.218513	1.053120	0.585349	0	7.424477	0.110204	0.082009	1
7.218493	1.126025	0.629251	0	7.424568	0.240412	0.165732	0
7.218476	1.199151	0.672090	0	7.424648	0.371677	0.247686	1
7.218020	-0.276607	-0.174668	0	7.424761	0.504264	0.327394	0
7.218020	-0.277094	-0.173781	0	7.424821	0.637103	0.406773	1
7.218020	-0.277391	-0.172816	0	7.424875	0.771413	0.483650	0
7.218020	-0.277488	-0.171811	0	7.424960	0.907439	0.557634	1
7.218020	-0.277379	-0.170808	0	7.424931	1.044598	0.629829	0
7.218021	-0.277069	-0.169847	0	7.424927	1.114282	0.664054	0
7.218021	-0.276571	-0.168969	0	7.424964	1.185146	0.695678	0
7.218021	-0.275905	-0.168208	0	7.630509	0.001982	-0.021954	0
7.218024	-0.262827	-0.156059	0	7.630509	0.002661	-0.022708	0
7.218028	-0.246074	-0.142545	0	7.630509	0.003479	-0.023311	0
7.218081	-0.211927	-0.116567	0	7.630509	0.004403	-0.023735	0
7.218073	-0.176679	-0.092582	0	7.630509	0.005394	-0.023966	0
7.218081	-0.141473	-0.068488	0	7.630510	0.006411	-0.023992	0
7.218151	-0.070625	-0.020991	0	7.630510	0.007413	-0.023814	0
7.218176	0.001353	0.024468	1	7.630511	0.008357	-0.023436	0
7.218266	0.145531	0.115106	0	7.630522	0.019602	-0.017564	0
7.218354	0.291538	0.202526	1	7.630537	0.034625	-0.008961	0
7.218407	0.438245	0.288757	0	7.630561	0.064334	0.008784	0
7.218444	0.585715	0.373708	1	7.630575	0.093882	0.026787	0
7.218472	0.734797	0.455847	0	7.630597	0.123390	0.044857	0
7.218526	0.885785	0.534671	1	7.630696	0.182472	0.080895	0
7.218516	1.038430	0.610679	0	7.630793	0.241497	0.117016	1
7.218495	1.115770	0.646934	0	7.630905	0.359360	0.189550	0
7.218478	1.194160	0.680697	0	7.631013	0.477173	0.262161	1
7.424249	-0.140155	-0.102206	0	7.631163	0.594935	0.334858	0
7.424249	-0.139486	-0.102970	0	7.631254	0.712570	0.407760	1
7.424249	-0.138677	-0.103582	0	7.631321	0.829998	0.480995	0
7.424249	-0.137761	-0.104020	0	7.631384	0.947120	0.554727	1
7.424249	-0.136774	-0.104265	0	7.631442	1.063905	0.629015	0
7.424250	-0.135758	-0.104305	0	7.631443	1.122359	0.666057	0
7.424250	-0.134755	-0.104141	0	7.631487	1.181228	0.701857	0
7.424251	-0.133807	-0.103778	0	7.630509	0.001982	-0.021954	0
7.424259	-0.120649	-0.097150	0	7.630509	0.001470	-0.021078	0
7.424272	-0.103666	-0.087861	0	7.630510	0.001146	-0.020117	0
7.424291	-0.070096	-0.068623	0	7.630510	0.001025	-0.019111	0
7.424303	-0.036713	-0.049076	0	7.630511	0.001109	-0.018101	0
7.424319	-0.003027	-0.030079	0	7.630512	0.001397	-0.017129	0
7.424399	0.063328	0.009756	0	7.630513	0.001877	-0.016236	0
7.424476	0.129988	0.049031	1	7.630514	0.002528	-0.015457	0
7.424568	0.263071	0.127960	0	7.630526	0.012369	-0.005906	0

TABLE A-I. — Continued. CM-1D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
7.630539	0.025808	0.005249	0	8.043321	0.302735	0.162884	0
7.630561	0.053334	0.026513	0	8.043320	0.303659	0.162472	0
7.630576	0.081258	0.047136	0	8.043320	0.304648	0.162254	0
7.630595	0.109433	0.067352	0	8.043320	0.305661	0.162240	0
7.630696	0.166382	0.106828	0	8.043320	0.306656	0.162430	0
7.630793	0.223723	0.145665	1	8.043321	0.307593	0.162816	0
7.630905	0.339140	0.222143	0	8.043330	0.314986	0.166776	0
7.631012	0.455467	0.297150	1	8.043349	0.325975	0.173523	0
7.631165	0.572628	0.370814	0	8.043384	0.347713	0.187383	0
7.631253	0.690602	0.443169	1	8.043405	0.369338	0.201411	0
7.631321	0.809585	0.513900	0	8.043427	0.390914	0.215513	0
7.631383	0.929795	0.582653	1	8.043548	0.434049	0.243744	0
7.631441	1.051518	0.648981	0	8.043659	0.477114	0.272075	1
7.631443	1.113232	0.680769	0	8.043805	0.563159	0.328868	0
7.631492	1.175997	0.710285	0	8.043938	0.649137	0.385759	1
7.836860	0.149285	0.066648	0	8.044124	0.735005	0.442815	0
7.836859	0.149972	0.065902	0	8.044245	0.820820	0.499957	1
7.836858	0.150797	0.065310	0	8.044349	0.906487	0.557324	0
7.836858	0.151723	0.064898	0	8.044448	0.991924	0.615041	1
7.836859	0.152716	0.064679	0	8.044578	1.077080	0.673184	0
7.836859	0.153733	0.064665	0	8.044594	1.119685	0.702215	0
7.836860	0.154731	0.064856	0	8.044614	1.162355	0.730772	0
7.836861	0.155671	0.065244	0	8.043323	0.301227	0.164217	0
7.836872	0.164968	0.070234	0	8.043324	0.300705	0.165083	0
7.836891	0.177982	0.078004	0	8.043325	0.300369	0.166037	0
7.836922	0.203728	0.093984	0	8.043327	0.300232	0.167039	0
7.836939	0.229338	0.110174	0	8.043328	0.300300	0.168048	0
7.836961	0.254907	0.126425	0	8.043330	0.300571	0.169024	0
7.837070	0.306094	0.158857	0	8.043331	0.301033	0.169924	0
7.837180	0.357220	0.191378	1	8.043332	0.301667	0.170713	0
7.837315	0.459352	0.256605	0	8.043342	0.308082	0.177182	0
7.837445	0.561446	0.321888	1	8.043357	0.317994	0.185553	0
7.837622	0.663476	0.387272	0	8.043384	0.338252	0.201642	0
7.837730	0.765443	0.452756	1	8.043404	0.358775	0.217333	0
7.837811	0.867263	0.518475	0	8.043425	0.379452	0.232790	0
7.837896	0.968841	0.584571	1	8.043547	0.421141	0.263200	0
7.837990	1.070134	0.651118	0	8.043661	0.463070	0.293243	1
7.837999	1.120852	0.684280	0	8.043804	0.547461	0.352528	0
7.838011	1.171739	0.716731	0	8.043939	0.632438	0.410930	1
7.836860	0.149285	0.066648	0	8.044129	0.717901	0.468597	0
7.836860	0.148764	0.067517	0	8.044244	0.803958	0.525374	1
7.836861	0.148429	0.068472	0	8.044348	0.890682	0.581146	0
7.836863	0.148295	0.069476	0	8.044445	0.978219	0.635697	1
7.836864	0.148368	0.070486	0	8.044576	1.066726	0.688792	0
7.836864	0.148645	0.071461	0	8.044593	1.111544	0.714485	0
7.836865	0.149112	0.072362	0	8.044609	1.156844	0.739079	0
7.836866	0.149752	0.073149	0	8.249875	0.456983	0.271568	0
7.836879	0.157899	0.081251	0	8.249874	0.457637	0.270799	0
7.836895	0.169582	0.091095	0	8.249873	0.458431	0.270179	0
7.836921	0.193498	0.109927	0	8.249873	0.459334	0.269729	0
7.836939	0.217747	0.128237	0	8.249872	0.460308	0.269470	0
7.836959	0.242203	0.146225	0	8.249872	0.461314	0.269410	0
7.837071	0.291604	0.181440	0	8.249871	0.462312	0.269555	0
7.837180	0.341324	0.216153	1	8.249871	0.463259	0.269896	0
7.837316	0.441409	0.284568	0	8.249873	0.469001	0.272649	0
7.837444	0.542262	0.351787	1	8.249880	0.478053	0.278048	0
7.837626	0.643792	0.417949	0	8.249896	0.495912	0.289206	0
7.837729	0.746051	0.482981	1	8.249908	0.513637	0.300556	0
7.837811	0.849173	0.546668	0	8.249924	0.531293	0.312007	0
7.837894	0.953342	0.608728	1	8.250018	0.566447	0.335140	0
7.837989	1.058772	0.668827	0	8.250113	0.601484	0.358441	1
7.837998	1.112221	0.697730	0	8.250237	0.671344	0.405358	0
7.838009	1.166360	0.725112	0	8.250356	0.740957	0.452635	1
8.043323	0.301227	0.164217	0	8.250542	0.810291	0.500313	0
8.043322	0.301913	0.163474	0	8.250668	0.879460	0.548237	1



TABLE A-I. — Concluded. CM-1D FORWARD COLD SHAPE COORDINATES  
 [Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z			Y	Z	
8.250788	0.948342	0.596577	0	8.249899	0.487295	0.301755	0
8.250917	1.016850	0.645461	1	8.249911	0.504204	0.314295	0
8.251097	1.084871	0.695055	0	8.249924	0.521192	0.326720	0
8.251129	1.118741	0.720060	0	8.250018	0.555269	0.351421	0
8.251161	1.152344	0.745156	0	8.250116	0.589456	0.375959	1
8.249875	0.456983	0.271568	0	8.250237	0.658093	0.424657	0
8.249876	0.456497	0.272451	0	8.250356	0.726963	0.473015	1
8.249876	0.456197	0.273414	0	8.250548	0.795996	0.521134	0
8.249877	0.456096	0.274417	0	8.250667	0.865349	0.568789	1
8.249878	0.456199	0.275420	0	8.250789	0.935025	0.615973	0
8.249878	0.456500	0.276383	0	8.250912	1.005102	0.662574	1
8.249879	0.456988	0.277264	0	8.251098	1.075617	0.708535	0
8.249879	0.457642	0.278030	0	8.251126	1.111139	0.731133	0
8.249882	0.462270	0.282451	0	8.251152	1.146689	0.753390	0
8.249887	0.470529	0.289007	0				



TABLE A-II. — CM-1D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.124907	-1.265673	0.536529	0	4.207410	0.041475	0.096001	0
4.124907	-1.263649	0.539673	0	4.207382	0.292923	-0.015314	1
4.124907	-1.261130	0.542435	0	4.207040	0.541436	-0.133190	0
4.124907	-1.258186	0.544739	0	4.206822	0.786365	-0.259544	1
4.124907	-1.254900	0.546521	0	4.206569	1.027063	-0.395745	0
4.124907	-1.251364	0.547730	0	4.206466	1.145828	-0.467524	0
4.124907	-1.247673	0.548332	0	4.206377	1.263803	-0.539752	0
4.124906	-1.243936	0.548312	0	4.207403	-1.262543	0.543840	0
4.124906	-1.224163	0.546550	0	4.207403	-1.264030	0.540411	0
4.124904	-1.188872	0.541721	0	4.207403	-1.264925	0.536782	0
4.124897	-1.120740	0.526276	0	4.207403	-1.265203	0.533054	0
4.124894	-1.054007	0.507554	0	4.207403	-1.264856	0.529333	0
4.124887	-0.987965	0.487194	0	4.207403	-1.263894	0.525721	0
4.124883	-0.857111	0.443585	0	4.207403	-1.262343	0.522320	0
4.124879	-0.727200	0.397760	1	4.207403	-1.260247	0.519226	0
4.124893	-0.469287	0.301658	0	4.207403	-1.244238	0.499718	0
4.124949	-0.213335	0.201010	1	4.207402	-1.218185	0.473337	0
4.124910	0.040785	0.095923	0	4.207396	-1.162894	0.427957	0
4.124888	0.292869	-0.013936	1	4.207394	-1.105743	0.386892	0
4.124613	0.542022	-0.130392	0	4.207387	-1.047505	0.348343	0
4.124316	0.787725	-0.255260	1	4.207382	-0.929182	0.275533	0
4.124066	1.029228	-0.390004	0	4.207379	-0.809137	0.206715	1
4.123960	1.148427	-0.461045	0	4.207394	-0.565497	0.077348	0
4.123837	1.266804	-0.532547	0	4.207447	-0.318183	-0.043442	1
4.124907	-1.265673	0.536529	0	4.207410	-0.067468	-0.156467	0
4.124907	-1.267143	0.533092	0	4.207382	0.186781	-0.261290	1
4.124907	-1.268021	0.529457	0	4.207041	0.445314	-0.355956	0
4.124907	-1.268281	0.525728	0	4.206825	0.709341	-0.438050	1
4.124907	-1.267916	0.522007	0	4.206570	0.980127	-0.504528	0
4.124907	-1.266935	0.518399	0	4.206469	1.118622	-0.530580	0
4.124907	-1.265369	0.515005	0	4.206377	1.259857	-0.548896	0
4.124907	-1.263260	0.511918	0	4.289898	-1.258754	0.550905	0
4.124906	-1.247128	0.492480	0	4.289898	-1.256703	0.554020	0
4.124904	-1.220925	0.466244	0	4.289898	-1.254164	0.556750	0
4.124897	-1.165390	0.421152	0	4.289898	-1.251204	0.559019	0
4.124894	-1.108012	0.380393	0	4.289898	-1.247909	0.560763	0
4.124887	-1.049564	0.342151	0	4.289898	-1.244368	0.561932	0
4.124883	-0.930841	0.269979	0	4.289898	-1.240682	0.562494	0
4.124879	-0.810412	0.201829	1	4.289898	-1.236954	0.562435	0
4.124893	-0.566054	0.073811	0	4.289898	-1.217135	0.560452	0
4.124949	-0.318061	-0.045576	1	4.289897	-1.181907	0.555226	0
4.124910	-0.066705	-0.157169	0	4.289890	-1.113963	0.539031	0
4.124888	0.188145	-0.260519	1	4.289888	-1.047451	0.519575	0
4.124615	0.447181	-0.353706	0	4.289883	-0.981653	0.498491	0
4.124318	0.711726	-0.434208	1	4.289878	-0.851321	0.453438	0
4.124068	0.982914	-0.499060	0	4.289876	-0.721965	0.406168	1
4.123962	1.121579	-0.524263	0	4.289891	-0.465214	0.307183	0
4.123838	1.262912	-0.541714	0	4.289934	-0.210475	0.203629	1
4.207403	-1.262543	0.543840	0	4.289896	0.042366	0.095668	0
4.207403	-1.260505	0.546974	0	4.289865	0.293107	-0.017071	1
4.207403	-1.257973	0.549724	0	4.289543	0.540945	-0.136321	0
4.207403	-1.255017	0.552013	0	4.289329	0.785106	-0.264022	1
4.207403	-1.251723	0.553778	0	4.289079	1.024964	-0.401556	0
4.207403	-1.248180	0.554971	0	4.288980	1.143287	-0.473992	0
4.207403	-1.244490	0.555556	0	4.288887	1.260810	-0.546908	0
4.207403	-1.240751	0.555519	0	4.289898	-1.258754	0.550905	0
4.207402	-1.220963	0.553655	0	4.289898	-1.260253	0.547491	0
4.207402	-1.185696	0.548630	0	4.289898	-1.261164	0.543875	0
4.207396	-1.117642	0.532827	0	4.289898	-1.261458	0.540158	0
4.207394	-1.051004	0.513746	0	4.289898	-1.261129	0.536444	0
4.207387	-0.985071	0.493033	0	4.289898	-1.260185	0.532837	0
4.207382	-0.854454	0.448712	0	4.289898	-1.258654	0.529437	0
4.207379	-0.724798	0.402165	1	4.289898	-1.256577	0.526342	0
4.207394	-0.467419	0.304638	0	4.289898	-1.240661	0.506787	0
4.207446	-0.212040	0.202537	1	4.289897	-1.214748	0.480307	0

TABLE A-II. — Continued. CM-1D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.289890	-1.159704	0.434688	0	4.504389	-1.236597	0.574879	0
4.289888	-1.102783	0.393355	0	4.504389	-1.233356	0.576517	0
4.289883	-1.044765	0.354522	0	4.504389	-1.229887	0.577589	0
4.289878	-0.926860	0.281122	0	4.504389	-1.226287	0.578061	0
4.289876	-0.807218	0.211689	1	4.504389	-1.222659	0.577921	0
4.289891	-0.564357	0.081019	0	4.504389	-1.202653	0.575450	0
4.289935	-0.317773	-0.041133	1	4.504388	-1.167691	0.569493	0
4.289896	-0.067764	-0.155553	0	4.504382	-1.100295	0.552042	0
4.289864	0.185811	-0.261832	1	4.504379	-1.034339	0.531438	0
4.289544	0.443772	-0.357991	0	4.504375	-0.969099	0.509265	0
4.289330	0.707237	-0.441659	1	4.504371	-0.839892	0.462133	0
4.289081	0.977507	-0.509819	0	4.504369	-0.711663	0.412855	1
4.288981	1.115775	-0.536756	0	4.504381	-0.457183	0.309990	0
4.288887	1.256812	-0.556027	0	4.504400	-0.204700	0.202725	1
4.388894	-1.252914	0.558805	0	4.504366	0.045863	0.091225	0
4.388894	-1.250862	0.561883	0	4.504304	0.294333	-0.024890	1
4.388894	-1.248324	0.564574	0	4.504045	0.539938	-0.147276	0
4.388894	-1.245373	0.566805	0	4.503845	0.781779	-0.277829	1
4.388894	-1.242090	0.568510	0	4.503608	1.019279	-0.417889	0
4.388894	-1.238568	0.569642	0	4.503514	1.136408	-0.491479	0
4.388894	-1.234907	0.570170	0	4.503427	1.252729	-0.565530	0
4.388894	-1.231210	0.570081	0	4.504389	-1.244066	0.567093	0
4.388894	-1.211327	0.567910	0	4.504389	-1.245568	0.563788	0
4.388892	-1.176183	0.562394	0	4.504389	-1.246494	0.560277	0
4.388890	-1.108458	0.545632	0	4.504389	-1.246817	0.556660	0
4.388884	-1.042136	0.525725	0	4.504389	-1.246527	0.553042	0
4.388878	-0.976551	0.504168	0	4.504389	-1.245631	0.549524	0
4.388874	-0.846661	0.458196	0	4.504389	-1.244159	0.546206	0
4.388872	-0.717757	0.410023	1	4.504389	-1.242148	0.543182	0
4.388885	-0.461923	0.309265	0	4.504389	-1.226326	0.523584	0
4.388912	-0.208108	0.203989	1	4.504388	-1.200740	0.497087	0
4.388880	0.043780	0.094364	0	4.504381	-1.146322	0.451200	0
4.388823	0.293573	-0.019990	1	4.504379	-1.090016	0.409455	0
4.388543	0.540468	-0.140784	0	4.504375	-1.032605	0.370125	0
4.388335	0.783601	-0.269944	1	4.504371	-0.915909	0.295587	0
4.388094	1.022389	-0.408838	0	4.504370	-0.797460	0.224881	1
4.387994	1.140157	-0.481938	0	4.504381	-0.556966	0.091375	0
4.387901	1.257098	-0.555533	0	4.504400	-0.312696	-0.033887	1
4.388894	-1.252914	0.558805	0	4.504366	-0.064992	-0.151651	0
4.388894	-1.254422	0.555426	0	4.504304	0.186315	-0.261550	1
4.388894	-1.255344	0.551844	0	4.504045	0.442093	-0.361648	0
4.388894	-1.255655	0.548158	0	4.503846	0.703345	-0.449676	1
4.388894	-1.255345	0.544471	0	4.503610	0.971433	-0.522723	0
4.388894	-1.254424	0.540889	0	4.503516	1.108622	-0.552360	0
4.388894	-1.252916	0.537511	0	4.503427	1.248594	-0.574589	0
4.388894	-1.250867	0.534432	0	4.636383	-1.231041	0.575104	0
4.388894	-1.235029	0.514842	0	4.636383	-1.229047	0.577985	0
4.388892	-1.209273	0.488314	0	4.636383	-1.226592	0.580486	0
4.388886	-1.154522	0.442500	0	4.636383	-1.223749	0.582534	0
4.388884	-1.097879	0.400923	0	4.636383	-1.220598	0.584069	0
4.388878	-1.040136	0.361813	0	4.636383	-1.217234	0.585045	0
4.388874	-0.922767	0.287811	0	4.636383	-1.213750	0.585437	0
4.388872	-0.803652	0.217723	1	4.636383	-1.210252	0.585234	0
4.388885	-0.561815	0.085628	0	4.636383	-1.190030	0.582296	0
4.388913	-0.316218	-0.038045	1	4.636382	-1.155375	0.575733	0
4.388880	-0.067185	-0.154066	0	4.636380	-1.088570	0.557247	0
4.388822	0.185459	-0.262038	1	4.636374	-1.023128	0.535843	0
4.388544	0.442550	-0.360007	0	4.636368	-0.958411	0.512894	0
4.388337	0.705126	-0.445639	1	4.636365	-0.830218	0.464338	0
4.388096	0.974549	-0.515947	0	4.636364	-0.702991	0.413723	1
4.387996	1.112408	-0.544066	0	4.636372	-0.450438	0.308418	0
4.387901	1.253037	-0.564626	0	4.636380	-0.199838	0.198920	1
4.504389	-1.244066	0.567093	0	4.636347	0.048885	0.085391	0
4.504389	-1.242028	0.570099	0	4.636271	0.295590	-0.032512	1
4.504389	-1.239515	0.572719	0	4.636038	0.539480	-0.156423	0



TABLE A-II. — Continued. CM-1D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.635851	0.779665	-0.288153	1	4.784854	-0.888834	0.313756	0
4.635625	1.015604	-0.428960	0	4.784852	-0.772292	0.242271	1
4.635532	1.131982	-0.502765	0	4.784854	-0.535731	0.106520	0
4.635452	1.247581	-0.576952	0	4.784849	-0.295523	-0.021670	1
4.636383	-1.231041	0.575104	0	4.784814	-0.052022	-0.143014	0
4.636383	-1.232516	0.571924	0	4.784733	0.194968	-0.257147	1
4.636383	-1.233430	0.568541	0	4.784528	0.446232	-0.362382	0
4.636383	-1.233755	0.565052	0	4.784360	0.702708	-0.456667	1
4.636383	-1.233482	0.561558	0	4.784154	0.965728	-0.537321	0
4.636383	-1.232620	0.558162	0	4.784065	1.100247	-0.571374	0
4.636383	-1.231193	0.554961	0	4.783963	1.237416	-0.598631	0
4.636383	-1.229243	0.552050	0	4.949865	-1.187134	0.587043	0
4.636383	-1.213330	0.532474	0	4.949865	-1.185351	0.589489	0
4.636382	-1.187902	0.506180	0	4.949865	-1.183166	0.591583	0
4.636380	-1.133872	0.460379	0	4.949865	-1.180645	0.593260	0
4.636374	-1.077928	0.418668	0	4.949865	-1.177868	0.594466	0
4.636369	-1.020920	0.379235	0	4.949864	-1.174923	0.595163	0
4.636365	-0.905044	0.304343	0	4.949864	-1.171901	0.595331	0
4.636364	-0.787448	0.233135	1	4.949864	-1.168896	0.594966	0
4.636372	-0.548673	0.098370	0	4.949864	-1.147856	0.590470	0
4.636380	-0.306168	-0.028440	1	4.949863	-1.114350	0.582101	0
4.636348	-0.060276	-0.148020	0	4.949858	-1.049551	0.560886	0
4.636271	0.189207	-0.259983	1	4.949855	-0.986004	0.537143	0
4.636038	0.443094	-0.362522	0	4.949849	-0.923066	0.512165	0
4.635853	0.702364	-0.453446	1	4.949845	-0.798288	0.459996	0
4.635626	0.968387	-0.529926	0	4.949842	-0.674316	0.406191	1
4.635534	1.104498	-0.561537	0	4.949843	-0.428082	0.295123	0
4.635452	1.243361	-0.585975	0	4.949834	-0.183474	0.180724	1
4.784878	-1.212536	0.582039	0	4.949796	0.059502	0.063023	0
4.784878	-1.210626	0.584734	0	4.949713	0.300720	-0.058266	1
4.784878	-1.208280	0.587057	0	4.949526	0.539478	-0.184538	0
4.784878	-1.205567	0.588941	0	4.949368	0.774963	-0.317339	1
4.784878	-1.202571	0.590328	0	4.949167	1.006699	-0.457697	0
4.784876	-1.199365	0.591206	0	4.949088	1.121192	-0.530656	0
4.784876	-1.196075	0.591491	0	4.949011	1.235069	-0.603646	0
4.784876	-1.192786	0.591204	0	4.949865	-1.187134	0.587043	0
4.784875	-1.172212	0.587597	0	4.949865	-1.188457	0.584320	0
4.784872	-1.138027	0.580234	0	4.949865	-1.189279	0.581407	0
4.784868	-1.072067	0.560494	0	4.949865	-1.189573	0.578395	0
4.784863	-1.007423	0.538014	0	4.949865	-1.189335	0.575378	0
4.784858	-0.943464	0.514112	0	4.949865	-1.188567	0.572450	0
4.784854	-0.816722	0.463852	0	4.949865	-1.187295	0.569704	0
4.784852	-0.690889	0.411703	1	4.949864	-1.185559	0.567225	0
4.784854	-0.441033	0.303626	0	4.949864	-1.168992	0.547748	0
4.784849	-0.193001	0.191723	1	4.949863	-1.143861	0.522453	0
4.784814	0.053249	0.076100	0	4.949858	-1.090651	0.477815	0
4.784733	0.297589	-0.043548	1	4.949855	-1.035723	0.436650	0
4.784528	0.539250	-0.168770	0	4.949849	-0.979788	0.397516	0
4.784358	0.777371	-0.301260	1	4.949846	-0.866204	0.322724	0
4.784151	1.011436	-0.442179	0	4.949842	-0.750989	0.251217	1
4.784063	1.126960	-0.515771	0	4.949843	-0.517301	0.114789	0
4.783961	1.241730	-0.589651	0	4.949834	-0.280092	-0.014564	1
4.784878	-1.212536	0.582039	0	4.949797	-0.039738	-0.137565	0
4.784878	-1.213950	0.579056	0	4.949713	0.203936	-0.253891	1
4.784878	-1.214829	0.575873	0	4.949526	0.451694	-0.361973	0
4.784878	-1.215144	0.572585	0	4.949368	0.704416	-0.459935	1
4.784878	-1.214888	0.569293	0	4.949169	0.963362	-0.545297	0
4.784878	-1.214067	0.566095	0	4.949089	1.095713	-0.582155	0
4.784876	-1.212692	0.563111	0	4.949011	1.230650	-0.612577	0
4.784876	-1.210833	0.560382	0	5.114853	-1.156688	0.588840	0
4.784875	-1.194665	0.540864	0	5.114853	-1.155038	0.591045	0
4.784872	-1.169372	0.514992	0	5.114853	-1.153019	0.592916	0
4.784868	-1.115719	0.469637	0	5.114853	-1.150698	0.594395	0
4.784863	-1.060227	0.428107	0	5.114853	-1.148149	0.595433	0
4.784858	-1.003697	0.388737	0	5.114853	-1.145453	0.595996	0



TABLE A-II. — Continued. CM-1D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
5.114853	-1.148149	0.595433	0	5.279215	0.998503	-0.488627	0
5.114853	-1.145453	0.595996	0	5.279144	1.110147	-0.560042	0
5.114853	-1.142701	0.596066	0	5.279083	1.221366	-0.631138	0
5.114853	-1.139982	0.595640	0	5.279837	-1.121091	0.587232	0
5.114853	-1.118526	0.590261	0	5.279837	-1.122221	0.585013	0
5.114853	-1.085763	0.580969	0	5.279837	-1.122928	0.582625	0
5.114841	-1.022238	0.558434	0	5.279837	-1.123185	0.580148	0
5.114840	-0.959917	0.533557	0	5.279837	-1.122987	0.577666	0
5.114838	-0.898166	0.507562	0	5.279837	-1.122337	0.575262	0
5.114829	-0.775577	0.453745	0	5.279837	-1.121259	0.573018	0
5.114823	-0.653734	0.398464	1	5.279836	-1.119789	0.571008	0
5.114820	-0.411623	0.284822	0	5.279836	-1.102530	0.551620	0
5.114812	-0.171013	0.168216	1	5.279834	-1.077868	0.527561	0
5.114765	0.068240	0.048876	0	5.279832	-1.025951	0.484395	0
5.114680	0.305841	-0.073704	1	5.279826	-0.972456	0.444236	0
5.114519	0.541180	-0.200720	0	5.279819	-0.918075	0.405767	0
5.114381	0.773523	-0.333559	1	5.279815	-0.807782	0.331758	0
5.114193	1.002425	-0.473127	0	5.279810	-0.696044	0.260508	1
5.114124	1.115635	-0.545349	0	5.279801	-0.469531	0.123783	0
5.114055	1.228305	-0.617443	0	5.279780	-0.239849	-0.006924	1
5.114853	-1.156688	0.588840	0	5.279742	-0.007345	-0.132231	0
5.114853	-1.157914	0.586376	0	5.279662	0.228173	-0.251817	1
5.114853	-1.158676	0.583731	0	5.279511	0.467331	-0.364449	0
5.114853	-1.158954	0.580993	0	5.279384	0.710903	-0.468581	1
5.114853	-1.158732	0.578249	0	5.279217	0.960053	-0.562053	0
5.114853	-1.158023	0.575591	0	5.279145	1.087218	-0.603831	0
5.114853	-1.156846	0.573102	0	5.279084	1.216744	-0.639965	0
5.114853	-1.155242	0.570865	0	5.527305	-1.057576	0.577577	0
5.114853	-1.138300	0.551426	0	5.527305	-1.056245	0.579244	0
5.114853	-1.113373	0.526742	0	5.527305	-1.054626	0.580632	0
5.114841	-1.060691	0.482913	0	5.527305	-1.052777	0.581695	0
5.114841	-1.006436	0.442190	0	5.527305	-1.050764	0.582393	0
5.114839	-0.951243	0.403317	0	5.527305	-1.048655	0.582703	0
5.114829	-0.839138	0.328911	0	5.527305	-1.046525	0.582614	0
5.114824	-0.725504	0.257506	1	5.527304	-1.044449	0.582129	0
5.114820	-0.495161	0.120749	0	5.527304	-1.022426	0.574740	0
5.114812	-0.261509	-0.009520	1	5.527303	-0.991760	0.563608	0
5.114765	-0.024744	-0.133748	0	5.527288	-0.932017	0.538414	0
5.114680	0.215114	-0.251894	1	5.527288	-0.873277	0.511396	0
5.114519	0.458829	-0.362463	0	5.527288	-0.814976	0.483577	0
5.114381	0.707247	-0.463727	1	5.527276	-0.699039	0.426692	0
5.114195	0.961554	-0.553403	0	5.527279	-0.583771	0.368604	1
5.114124	1.091442	-0.592866	0	5.527260	-0.354105	0.250758	0
5.114055	1.223783	-0.626321	0	5.527244	-0.125669	0.130677	1
5.279837	-1.121091	0.587232	0	5.527209	0.101693	0.008622	0
5.279837	-1.119574	0.589208	0	5.527128	0.327992	-0.115443	1
5.279836	-1.117720	0.590872	0	5.527009	0.552307	-0.243076	0
5.279836	-1.115595	0.592171	0	5.526902	0.774319	-0.374901	1
5.279836	-1.113267	0.593058	0	5.526753	0.993670	-0.511603	0
5.279836	-1.110817	0.593507	0	5.526691	1.102407	-0.581662	0
5.279836	-1.108326	0.593500	0	5.526640	1.210874	-0.651147	0
5.279836	-1.105879	0.593038	0	5.527305	-1.057576	0.577577	0
5.279835	-1.084102	0.586811	0	5.527305	-1.058570	0.575692	0
5.279834	-1.052130	0.576710	0	5.527305	-1.059196	0.573655	0
5.279832	-0.990107	0.552846	0	5.527305	-1.059429	0.571536	0
5.279819	-0.929051	0.527114	0	5.527305	-1.059264	0.569411	0
5.279819	-0.868585	0.500275	0	5.527305	-1.058703	0.567356	0
5.279815	-0.748505	0.444957	0	5.527305	-1.057768	0.565440	0
5.279810	-0.629097	0.388352	1	5.527305	-1.056494	0.563732	0
5.279801	-0.391578	0.272644	0	5.527304	-1.038943	0.544463	0
5.279780	-0.155375	0.154392	1	5.527303	-1.014835	0.521312	0
5.279742	0.079488	0.033589	0	5.527288	-0.964162	0.479493	0
5.279662	0.312945	-0.089934	1	5.527288	-0.912178	0.440094	0
5.279511	0.544341	-0.217388	0	5.527288	-0.859371	0.402200	0
5.279383	0.772977	-0.350042	1	5.527277	-0.752234	0.329188	0

TABLE A-II. — Continued. CM-1D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
5.527280	-0.643866	0.258451	1	5.980967	-0.894646	0.534621	0
5.527260	-0.424120	0.122420	0	5.980966	-0.872977	0.525573	0
5.527244	-0.201587	-0.008481	1	5.980965	-0.845087	0.513231	0
5.527209	0.023598	-0.134526	0	5.980949	-0.790472	0.486539	0
5.527128	0.251682	-0.255320	1	5.980949	-0.736671	0.458472	0
5.527009	0.482885	-0.370326	0	5.980954	-0.683192	0.429844	0
5.526903	0.718211	-0.477748	1	5.980942	-0.576645	0.371890	0
5.526754	0.958659	-0.575780	0	5.980935	-0.470471	0.313286	1
5.526692	1.081268	-0.620413	0	5.980931	-0.259041	0.194537	0
5.526640	1.206100	-0.659896	0	5.980924	-0.048361	0.074495	1
5.774762	-0.980181	0.557489	0	5.980900	0.161578	-0.046799	0
5.774762	-0.979026	0.558884	0	5.980849	0.370881	-0.169217	1
5.774762	-0.977625	0.560035	0	5.980802	0.578654	-0.294199	0
5.774762	-0.976032	0.560898	0	5.980717	0.784778	-0.422001	1
5.774762	-0.974303	0.561443	0	5.980614	0.988854	-0.553281	0
5.774762	-0.972503	0.561649	0	5.980569	1.090265	-0.619983	0
5.774762	-0.970696	0.561509	0	5.980522	1.191586	-0.685881	0
5.774762	-0.968949	0.561029	0	5.980967	-0.904437	0.531773	0
5.774761	-0.946988	0.552653	0	5.980967	-0.905208	0.530403	0
5.774761	-0.917773	0.540747	0	5.980967	-0.905700	0.528911	0
5.774747	-0.860698	0.514534	0	5.980967	-0.905895	0.527351	0
5.774746	-0.804504	0.486779	0	5.980967	-0.905785	0.525785	0
5.774748	-0.748689	0.458355	0	5.980967	-0.905376	0.524268	0
5.774734	-0.637587	0.400562	0	5.980967	-0.904682	0.522858	0
5.774727	-0.526939	0.341960	1	5.980967	-0.903728	0.521610	0
5.774719	-0.306677	0.222955	0	5.980966	-0.886263	0.502898	0
5.774707	-0.087321	0.102342	1	5.980965	-0.863661	0.481528	0
5.774657	0.131336	-0.019546	0	5.980950	-0.816356	0.442359	0
5.774608	0.348790	-0.143509	1	5.980949	-0.768010	0.404983	0
5.774546	0.564731	-0.270132	0	5.980955	-0.718978	0.368766	0
5.774434	0.778747	-0.400144	1	5.980942	-0.619556	0.298650	0
5.774311	0.990419	-0.534264	0	5.980935	-0.518985	0.230485	1
5.774260	1.095496	-0.602656	0	5.980931	-0.315645	0.097926	0
5.774210	1.200394	-0.670348	0	5.980924	-0.109828	-0.030416	1
5.774762	-0.980181	0.557489	0	5.980900	0.098244	-0.154896	0
5.774762	-0.981051	0.555900	0	5.980849	0.308863	-0.275069	1
5.774762	-0.981601	0.554174	0	5.980803	0.522045	-0.390819	0
5.774762	-0.981814	0.552375	0	5.980717	0.738743	-0.500576	1
5.774762	-0.981679	0.550568	0	5.980615	0.959646	-0.603134	0
5.774762	-0.981204	0.548821	0	5.980569	1.072135	-0.650929	0
5.774762	-0.980406	0.547195	0	5.980522	1.186545	-0.694479	0
5.774762	-0.979313	0.545750	0	6.187161	-0.818470	0.497327	0
5.774761	-0.961707	0.526720	0	6.187161	-0.817576	0.498344	0
5.774761	-0.938345	0.504503	0	6.187161	-0.816501	0.499169	0
5.774747	-0.889357	0.464036	0	6.187161	-0.815286	0.499768	0
5.774746	-0.839195	0.425658	0	6.187161	-0.813976	0.500119	0
5.774749	-0.788294	0.388575	0	6.187160	-0.812624	0.500208	0
5.774735	-0.685058	0.316921	0	6.187160	-0.811281	0.500033	0
5.774727	-0.580585	0.247438	1	6.187160	-0.809997	0.499600	0
5.774720	-0.369226	0.112747	0	6.187160	-0.788833	0.490032	0
5.774707	-0.155195	-0.017249	1	6.187159	-0.762377	0.477431	0
5.774657	0.061460	-0.142666	0	6.187143	-0.710443	0.450598	0
5.774608	0.280435	-0.263949	1	6.187143	-0.659271	0.422515	0
5.774546	0.502442	-0.379882	0	6.187155	-0.608373	0.393960	0
5.774434	0.728246	-0.489126	1	6.187141	-0.506857	0.336407	0
5.774312	0.958640	-0.590261	0	6.187140	-0.405642	0.278339	1
5.774261	1.076032	-0.636953	0	6.187141	-0.204034	0.160870	0
5.774210	1.195477	-0.679013	0	6.187143	-0.003044	0.042367	1
5.980967	-0.904437	0.531773	0	6.187131	0.197360	-0.077096	0
5.980967	-0.903417	0.532969	0	6.187100	0.397293	-0.197358	1
5.980967	-0.902185	0.533946	0	6.187042	0.595761	-0.320010	0
5.980967	-0.900788	0.534668	0	6.186992	0.792816	-0.444988	1
5.980967	-0.899278	0.535107	0	6.186925	0.988432	-0.572368	0
5.980967	-0.897713	0.535247	0	6.186891	1.085627	-0.637061	0
5.980967	-0.896149	0.535083	0	6.186848	1.182804	-0.700876	0



TABLE A-II. — Continued. CM-1D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
6.187161	-0.818470	0.497327	0	6.393368	0.187121	-0.193025	0
6.187161	-0.819148	0.496155	0	6.393360	0.377643	-0.308704	1
6.187161	-0.819585	0.494873	0	6.393325	0.570064	-0.421314	0
6.187161	-0.819763	0.493530	0	6.393291	0.765459	-0.529137	1
6.187161	-0.819675	0.492180	0	6.393253	0.964704	-0.630788	0
6.187161	-0.819327	0.490873	0	6.393196	1.065681	-0.679425	0
6.187161	-0.818729	0.489658	0	6.393167	1.168627	-0.724062	0
6.187161	-0.817904	0.488584	0	6.599528	-0.618047	0.401637	0
6.187160	-0.800748	0.470314	0	6.599528	-0.617366	0.402368	0
6.187159	-0.779041	0.449852	0	6.599528	-0.616554	0.402951	0
6.187143	-0.733674	0.412150	0	6.599527	-0.615642	0.403361	0
6.187144	-0.687405	0.375954	0	6.599527	-0.614666	0.403582	0
6.187156	-0.640507	0.340778	0	6.599527	-0.613667	0.403604	0
6.187142	-0.545410	0.272604	0	6.599527	-0.612683	0.403429	0
6.187140	-0.449246	0.206177	1	6.599527	-0.611753	0.403063	0
6.187141	-0.254951	0.076605	0	6.599526	-0.592248	0.392993	0
6.187143	-0.058383	-0.049218	1	6.599526	-0.568946	0.380424	0
6.187131	0.140283	-0.171553	0	6.599527	-0.523231	0.353899	0
6.187100	0.341333	-0.289968	1	6.599514	-0.477666	0.327145	0
6.187067	0.544682	-0.404542	0	6.599540	-0.432592	0.299582	0
6.186992	0.751050	-0.514108	1	6.599530	-0.342423	0.244568	0
6.186926	0.961681	-0.616638	0	6.599554	-0.252777	0.188706	1
6.186892	1.068769	-0.664958	0	6.599570	-0.073225	0.077411	0
6.186849	1.177649	-0.709406	0	6.599605	0.105585	-0.035053	1
6.393347	-0.722761	0.453943	0	6.599617	0.284101	-0.147950	0
6.393347	-0.721983	0.454803	0	6.599636	0.462449	-0.261114	1
6.393347	-0.721050	0.455495	0	6.599623	0.639513	-0.376279	0
6.393347	-0.719998	0.455989	0	6.599607	0.815676	-0.492833	1
6.393347	-0.718871	0.456267	0	6.599566	0.990680	-0.611205	0
6.393347	-0.717711	0.456318	0	6.599538	1.077877	-0.670863	0
6.393347	-0.716564	0.456139	0	6.599515	1.165248	-0.729468	0
6.393347	-0.715474	0.455739	0	6.599528	-0.618047	0.401637	0
6.393346	-0.695026	0.445819	0	6.599528	-0.618568	0.400785	0
6.393345	-0.670104	0.433142	0	6.599528	-0.618910	0.399846	0
6.393331	-0.621054	0.406507	0	6.599528	-0.619057	0.398859	0
6.393332	-0.572728	0.378715	0	6.599528	-0.619005	0.397863	0
6.393350	-0.524634	0.350523	0	6.599527	-0.618755	0.396897	0
6.393336	-0.428593	0.293949	0	6.599527	-0.618318	0.395999	0
6.393353	-0.333055	0.236552	1	6.599527	-0.617711	0.395207	0
6.393353	-0.141943	0.121816	0	6.599526	-0.601718	0.378218	0
6.393369	0.048401	0.005844	1	6.599526	-0.582184	0.359771	0
6.393368	0.238305	-0.110815	0	6.599527	-0.541682	0.325110	0
6.393360	0.427896	-0.227991	1	6.599515	-0.500017	0.292273	0
6.393325	0.616125	-0.347334	0	6.599540	-0.458132	0.259736	0
6.393291	0.803207	-0.468508	1	6.599530	-0.373091	0.196720	0
6.393230	0.988897	-0.591921	0	6.599554	-0.287498	0.134533	1
6.393195	1.081339	-0.654273	0	6.599570	-0.113839	0.014048	0
6.393167	1.173894	-0.715602	0	6.599605	0.061356	-0.104059	1
6.393347	-0.722761	0.453943	0	6.599617	0.238373	-0.219293	0
6.393347	-0.723355	0.452945	0	6.599636	0.417484	-0.331267	1
6.393347	-0.723740	0.451851	0	6.599624	0.598193	-0.440745	0
6.393347	-0.723901	0.450702	0	6.599608	0.781653	-0.545914	1
6.393347	-0.723833	0.449544	0	6.599568	0.968380	-0.645996	0
6.393347	-0.723538	0.448423	0	6.599539	1.063326	-0.693567	0
6.393347	-0.723028	0.447381	0	6.599515	1.159871	-0.737855	0
6.393347	-0.722321	0.446463	0	6.805702	-0.505363	0.340744	0
6.393346	-0.705649	0.428757	0	6.805702	-0.504670	0.341471	0
6.393345	-0.684968	0.409268	0	6.805702	-0.503845	0.342045	0
6.393332	-0.641786	0.373209	0	6.805702	-0.502922	0.342443	0
6.393332	-0.597840	0.338380	0	6.805702	-0.501938	0.342650	0
6.393350	-0.553329	0.304435	0	6.805702	-0.500933	0.342656	0
6.393337	-0.463038	0.238626	0	6.805702	-0.499946	0.342462	0
6.393353	-0.372038	0.173940	1	6.805702	-0.499020	0.342075	0
6.393353	-0.187502	0.048641	0	6.805701	-0.481164	0.332416	0
6.393369	-0.001166	-0.073768	1	6.805701	-0.459575	0.320098	0



TABLE A-II. — Continued. CM-1D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
6.805703	-0.417160	0.294306	0	7.011876	-0.387642	0.269406	0
6.805717	-0.374953	0.268182	0	7.011876	-0.387607	0.268400	0
6.805729	-0.332931	0.241778	0	7.011876	-0.387371	0.267422	0
6.805743	-0.249220	0.188486	0	7.011876	-0.386943	0.266510	0
6.805758	-0.165680	0.134931	1	7.011877	-0.386339	0.265704	0
6.805798	0.001494	0.027979	0	7.011878	-0.372925	0.251172	0
6.805854	0.167943	-0.080108	1	7.011879	-0.355944	0.235067	0
6.805882	0.334249	-0.188376	0	7.011884	-0.320870	0.204496	0
6.805909	0.500146	-0.297264	1	7.011906	-0.284924	0.175196	0
6.805936	0.665589	-0.406841	0	7.011927	-0.248635	0.146404	0
6.805940	0.830003	-0.517970	1	7.011953	-0.175332	0.089907	0
6.805923	0.993482	-0.630525	0	7.011978	-0.101382	0.034366	1
6.805900	1.075010	-0.687120	0	7.012054	0.048205	-0.074230	0
6.805882	1.156755	-0.742658	0	7.012117	0.199262	-0.180643	1
6.805702	-0.505363	0.340744	0	7.012165	0.351660	-0.285068	0
6.805702	-0.505898	0.339894	0	7.012212	0.505444	-0.387451	1
6.805702	-0.506251	0.338955	0	7.012276	0.661084	-0.487093	0
6.805702	-0.506409	0.337965	0	7.012300	0.818639	-0.583906	1
6.805702	-0.506365	0.336962	0	7.012307	0.978804	-0.676871	0
6.805702	-0.506122	0.335990	0	7.012293	1.060168	-0.721459	0
6.805702	-0.505689	0.335086	0	7.012281	1.142878	-0.763401	0
6.805702	-0.505084	0.334285	0	7.218065	-0.262193	0.196106	0
6.805701	-0.490348	0.318485	0	7.218066	-0.261476	0.196820	0
6.805702	-0.472045	0.301184	0	7.218066	-0.260628	0.197376	0
6.805704	-0.434172	0.268502	0	7.218066	-0.259686	0.197751	0
6.805717	-0.395360	0.237228	0	7.218066	-0.258688	0.197930	0
6.805730	-0.356115	0.206615	0	7.218066	-0.257674	0.197905	0
6.805743	-0.276865	0.146553	0	7.218066	-0.256687	0.197677	0
6.805758	-0.196855	0.087647	1	7.218066	-0.255764	0.197257	0
6.805798	-0.034795	-0.027065	0	7.218069	-0.241369	0.188819	0
6.805854	0.128510	-0.139919	1	7.218074	-0.223335	0.177496	0
6.805882	0.293520	-0.250153	0	7.218118	-0.188002	0.153731	0
6.805909	0.460087	-0.358024	1	7.218116	-0.152367	0.130500	0
6.805937	0.628735	-0.462740	0	7.218124	-0.117184	0.106579	0
6.805942	0.799520	-0.564206	1	7.218191	-0.047080	0.058296	0
6.805924	0.973230	-0.661241	0	7.218220	0.023526	0.010834	1
6.805901	1.061517	-0.707586	0	7.218315	0.163714	-0.085680	0
6.805883	1.151274	-0.750973	0	7.218409	0.304446	-0.181333	1
7.011876	-0.386561	0.272184	0	7.218478	0.444640	-0.277786	0
7.011876	-0.385855	0.272906	0	7.218543	0.584332	-0.374990	1
7.011876	-0.385018	0.273471	0	7.218597	0.723916	-0.472320	0
7.011876	-0.384085	0.273858	0	7.218682	0.863350	-0.569830	1
7.011876	-0.383094	0.274050	0	7.218712	1.001826	-0.668752	0
7.011876	-0.382083	0.274040	0	7.218708	1.070993	-0.718315	0
7.011876	-0.381096	0.273828	0	7.218702	1.140429	-0.766891	0
7.011877	-0.380172	0.273422	0	7.218065	-0.262193	0.196106	0
7.011877	-0.364024	0.264308	0	7.218066	-0.262752	0.195263	0
7.011879	-0.344195	0.252407	0	7.218066	-0.263128	0.194325	0
7.011884	-0.305184	0.227643	0	7.218066	-0.263307	0.193332	0
7.011906	-0.266301	0.202680	0	7.218066	-0.263281	0.192323	0
7.011927	-0.227606	0.177437	0	7.218066	-0.263052	0.191340	0
7.011953	-0.150442	0.126639	0	7.218066	-0.262627	0.190423	0
7.011979	-0.073438	0.075606	1	7.218066	-0.262026	0.189611	0
7.012054	0.080575	-0.026459	0	7.218069	-0.249994	0.176425	0
7.012116	0.234342	-0.128874	1	7.218074	-0.234413	0.161576	0
7.012165	0.387855	-0.231656	0	7.218118	-0.202468	0.132942	0
7.012212	0.541045	-0.334913	1	7.218116	-0.169353	0.106092	0
7.012273	0.693895	-0.438673	0	7.218124	-0.136245	0.079188	0
7.012299	0.845920	-0.543645	1	7.218191	-0.069471	0.026121	0
7.012305	0.997205	-0.649718	0	7.218218	-0.001478	-0.025094	1
7.012291	1.072707	-0.702958	0	7.218315	0.134889	-0.127102	0
7.012280	1.148462	-0.755160	0	7.218410	0.273324	-0.226053	1
7.011876	-0.386561	0.272184	0	7.218479	0.412561	-0.323881	0
7.011876	-0.387108	0.271338	0	7.218543	0.552746	-0.420381	1
7.011876	-0.387474	0.270398	0	7.218597	0.694731	-0.514259	0

TABLE A-II. — Continued. CM-1D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
7.218684	0.838971	-0.604863	1	7.630734	0.174838	-0.095456	0
7.218714	0.985101	-0.692786	0	7.630824	0.231027	-0.135851	1
7.218710	1.059317	-0.735092	0	7.630941	0.343149	-0.216977	0
7.218703	1.134744	-0.775058	0	7.631046	0.455244	-0.298135	1
7.424289	-0.132400	0.112420	0	7.631203	0.567422	-0.379178	0
7.424289	-0.131673	0.113128	0	7.631302	0.679393	-0.460503	1
7.424311	-0.130994	0.113381	0	7.631394	0.791139	-0.542137	0
7.424311	-0.130045	0.113745	0	7.631475	0.902572	-0.624191	1
7.424312	-0.129043	0.113910	0	7.631565	1.013766	-0.706564	0
7.424312	-0.128027	0.113871	0	7.631573	1.069289	-0.747857	0
7.424313	-0.127039	0.113628	0	7.631619	1.125428	-0.787792	0
7.424313	-0.126122	0.113192	0	7.630577	0.002577	0.020662	0
7.424320	-0.113527	0.105547	0	7.630577	0.002000	0.019827	0
7.424331	-0.097328	0.094947	0	7.630578	0.001604	0.018895	0
7.424346	-0.065383	0.073116	0	7.630578	0.001406	0.017902	0
7.424356	-0.033654	0.050987	0	7.630579	0.001414	0.016890	0
7.424371	-0.001594	0.029369	0	7.630580	0.001628	0.015899	0
7.424439	0.061472	-0.015499	0	7.630580	0.002039	0.014972	0
7.424510	0.124871	-0.059842	1	7.630581	0.002629	0.014147	0
7.424603	0.251366	-0.148949	0	7.630590	0.011723	0.003886	0
7.424698	0.377807	-0.238126	1	7.630602	0.024281	-0.008247	0
7.424819	0.504576	-0.326801	0	7.630621	0.050123	-0.031526	0
7.424907	0.630525	-0.416701	1	7.630633	0.076402	-0.054204	0
7.424983	0.756445	-0.506597	0	7.630650	0.102965	-0.076491	0
7.425050	0.881959	-0.597069	1	7.630735	0.156816	-0.120085	0
7.425105	1.007109	-0.688039	0	7.630824	0.211119	-0.163057	1
7.425107	1.069591	-0.733659	0	7.630940	0.320502	-0.247930	0
7.425147	1.132735	-0.777773	0	7.631046	0.430931	-0.331364	1
7.424289	-0.132400	0.112420	0	7.631205	0.542441	-0.413319	0
7.424289	-0.132967	0.111582	0	7.631303	0.654786	-0.494134	1
7.424311	-0.133534	0.110351	0	7.631393	0.768274	-0.573384	0
7.424312	-0.133722	0.109357	0	7.631474	0.883162	-0.650719	1
7.424312	-0.133706	0.108345	0	7.631564	0.999891	-0.725528	0
7.424313	-0.133485	0.107357	0	7.631573	1.059062	-0.761833	0
7.424313	-0.133068	0.106434	0	7.631622	1.119567	-0.795799	0
7.424314	-0.132471	0.105614	0	7.836894	0.143048	-0.078405	0
7.424321	-0.121887	0.093838	0	7.836893	0.143788	-0.077711	0
7.424331	-0.107785	0.080301	0	7.836893	0.144652	-0.077180	0
7.424346	-0.078733	0.054419	0	7.836892	0.145607	-0.076835	0
7.424356	-0.049161	0.029267	0	7.836893	0.146612	-0.076689	0
7.424371	-0.018854	0.005196	0	7.836893	0.147627	-0.076748	0
7.424439	0.041364	-0.043661	0	7.836894	0.148610	-0.077010	0
7.424511	0.102526	-0.091140	1	7.836895	0.149519	-0.077464	0
7.424604	0.225772	-0.184796	0	7.836906	0.158439	-0.083105	0
7.424697	0.350233	-0.276747	1	7.836925	0.170866	-0.091783	0
7.424820	0.476232	-0.366494	0	7.836954	0.195405	-0.109563	0
7.424907	0.602592	-0.455824	1	7.836969	0.219787	-0.127549	0
7.424982	0.730570	-0.542838	0	7.836990	0.244131	-0.145584	0
7.425092	0.860579	-0.626972	1	7.837091	0.292921	-0.181526	0
7.425105	0.991866	-0.709388	0	7.837189	0.341678	-0.217502	1
7.425107	1.058667	-0.748956	0	7.837311	0.439008	-0.289696	0
7.425150	1.126961	-0.785859	0	7.837430	0.536326	-0.361905	1
7.630577	0.002577	0.020662	0	7.837601	0.633730	-0.433996	0
7.630577	0.003312	0.021362	0	7.837715	0.730988	-0.506283	1
7.630577	0.004174	0.021900	0	7.837818	0.828072	-0.578802	0
7.630577	0.005128	0.022254	0	7.837919	0.924922	-0.651632	1
7.630577	0.006133	0.022409	0	7.838034	1.021610	-0.724658	0
7.630578	0.007150	0.022358	0	7.838048	1.069881	-0.761277	0
7.630578	0.008136	0.022104	0	7.838062	1.118402	-0.797158	0
7.630579	0.009050	0.021657	0	7.836894	0.143048	-0.078405	0
7.630589	0.019822	0.014955	0	7.836894	0.142466	-0.079233	0
7.630601	0.034156	0.005248	0	7.836895	0.142063	-0.080162	0
7.630621	0.062443	-0.014687	0	7.836896	0.141859	-0.081152	0
7.630632	0.090541	-0.034879	0	7.836898	0.141859	-0.082165	0
7.630651	0.118600	-0.055125	0	7.836899	0.142065	-0.083156	0



TABLE A-II. — Continued. CM-1D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
7.836900	0.142466	-0.084087	0	8.044527	1.106298	-0.812808	0
7.836901	0.143050	-0.084918	0	8.249728	0.438896	-0.300226	0
7.836912	0.150595	-0.093580	0	8.249728	0.439594	-0.299501	0
7.836928	0.161546	-0.104232	0	8.249727	0.440423	-0.298931	0
7.836953	0.184052	-0.124724	0	8.249726	0.441350	-0.298539	0
7.836969	0.206925	-0.144726	0	8.249726	0.442336	-0.298341	0
7.836988	0.230031	-0.164415	0	8.249725	0.443344	-0.298345	0
7.837091	0.276843	-0.202999	0	8.249725	0.444331	-0.298549	0
7.837190	0.324037	-0.241064	1	8.249725	0.445256	-0.298947	0
7.837311	0.419096	-0.316291	0	8.249727	0.450823	-0.302039	0
7.837431	0.515037	-0.390339	1	8.249734	0.459547	-0.307957	0
7.837605	0.611893	-0.463161	0	8.249751	0.476734	-0.320127	0
7.837713	0.709462	-0.535032	1	8.249763	0.493767	-0.332493	0
7.837819	0.807997	-0.605614	0	8.249775	0.510719	-0.344964	0
7.837916	0.907713	-0.674615	1	8.249848	0.544556	-0.369985	0
7.838033	1.009001	-0.741500	0	8.249927	0.578261	-0.395176	1
7.838047	1.060302	-0.774074	0	8.250033	0.645368	-0.445949	0
7.838060	1.112414	-0.805156	0	8.250142	0.712224	-0.497044	1
8.043309	0.288530	-0.185399	0	8.250313	0.778926	-0.548328	0
8.043308	0.289263	-0.184704	0	8.250433	0.845341	-0.599985	1
8.043307	0.290122	-0.184172	0	8.250544	0.911445	-0.652043	0
8.043306	0.291071	-0.183824	0	8.250666	0.977161	-0.704598	1
8.043306	0.292072	-0.183674	0	8.250847	1.042497	-0.757640	0
8.043306	0.293083	-0.183727	0	8.250875	1.074863	-0.784552	0
8.043306	0.294064	-0.183984	0	8.250901	1.106954	-0.811544	0
8.043307	0.294973	-0.184431	0	8.249728	0.438896	-0.300226	0
8.043315	0.302092	-0.188866	0	8.249729	0.438359	-0.301075	0
8.043330	0.312621	-0.196314	0	8.249730	0.438003	-0.302016	0
8.043357	0.333408	-0.211564	0	8.249731	0.437843	-0.303009	0
8.043372	0.354058	-0.226992	0	8.249731	0.437886	-0.304015	0
8.043392	0.374661	-0.242483	0	8.249732	0.438128	-0.304992	0
8.043498	0.415926	-0.273387	0	8.249732	0.438563	-0.305900	0
8.043592	0.457128	-0.304366	1	8.249733	0.439172	-0.306703	0
8.043728	0.539372	-0.366538	0	8.249736	0.443528	-0.311390	0
8.043851	0.621564	-0.428776	1	8.249741	0.451386	-0.318419	0
8.044019	0.703785	-0.490966	0	8.249753	0.467375	-0.332125	0
8.044141	0.785865	-0.553345	1	8.249763	0.483516	-0.345635	0
8.044245	0.867771	-0.615950	0	8.249774	0.499739	-0.359040	0
8.044353	0.949453	-0.678845	1	8.249850	0.532410	-0.385557	0
8.044497	1.030979	-0.741932	0	8.249929	0.565199	-0.411920	1
8.044514	1.071623	-0.773641	0	8.250034	0.630970	-0.464406	0
8.044532	1.112377	-0.804858	0	8.250142	0.697018	-0.516538	1
8.043309	0.288530	-0.185399	0	8.250319	0.763407	-0.568222	0
8.043310	0.287952	-0.186226	0	8.250431	0.830010	-0.619639	1
8.043311	0.287553	-0.187154	0	8.250544	0.896971	-0.670597	0
8.043312	0.287352	-0.188143	0	8.250660	0.964381	-0.720983	1
8.043314	0.287353	-0.189153	0	8.250847	1.032442	-0.770530	0
8.043315	0.287558	-0.190142	0	8.250873	1.066595	-0.795152	0
8.043316	0.287960	-0.191070	0	8.250894	1.100788	-0.819450	0
8.043317	0.288540	-0.191899	0				
8.043324	0.294515	-0.198772	0				
8.043336	0.303857	-0.207773	0				
8.043358	0.323012	-0.225156	0				
8.043374	0.342451	-0.242166	0				
8.043391	0.362063	-0.258952	0				
8.043495	0.401742	-0.291930	0				
8.043595	0.441699	-0.324539	1				
8.043726	0.522124	-0.389089	0				
8.043850	0.603214	-0.452765	1				
8.044024	0.685002	-0.515522	0				
8.044139	0.767332	-0.577574	1				
8.044245	0.850404	-0.638654	0				
8.044351	0.934384	-0.698547	1				
8.044496	1.019600	-0.756807	0				
8.044512	1.062670	-0.785345	0				



TABLE A-III. — CM-2D FORWARD COLD SHAPE COORDINATES  
 [Number of cross sectional cuts, 21; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.124050	-1.181150	-1.026516	0	4.203506	0.055763	-0.069776	0
4.124051	-1.178534	-1.028678	0	4.203560	0.300821	0.124173	1
4.124052	-1.175577	-1.030342	0	4.203107	0.542396	0.322551	0
4.124052	-1.172373	-1.031454	0	4.202542	0.779756	0.526364	1
4.124053	-1.169022	-1.031979	0	4.202085	1.011430	0.737418	0
4.124053	-1.165634	-1.031900	0	4.201869	1.125132	0.845637	0
4.124053	-1.162314	-1.031220	0	4.201540	1.238225	0.953683	0
4.124052	-1.159168	-1.029963	0	4.202869	-1.234109	-0.956799	0
4.124058	-1.136325	-1.018386	0	4.202871	-1.236030	-0.954230	0
4.124083	-1.101189	-0.999070	0	4.202872	-1.237458	-0.951356	0
4.124141	-1.034559	-0.956373	0	4.202874	-1.238346	-0.948272	0
4.124174	-0.970234	-0.911048	0	4.202875	-1.238666	-0.945077	0
4.124247	-0.906761	-0.864742	0	4.202876	-1.238408	-0.941877	0
4.124322	-0.781968	-0.769689	0	4.202877	-1.237579	-0.938775	0
4.124429	-0.658569	-0.673015	1	4.202878	-1.236211	-0.935871	0
4.124660	-0.414920	-0.476203	0	4.202882	-1.220959	-0.910155	0
4.124893	-0.174584	-0.275732	1	4.202885	-1.197530	-0.876718	0
4.124802	0.062637	-0.071492	0	4.202955	-1.146189	-0.815429	0
4.124812	0.296664	0.136300	1	4.202966	-1.092608	-0.757102	0
4.124438	0.526708	0.348692	0	4.202995	-1.037487	-0.700681	0
4.123888	0.751886	0.566563	1	4.203081	-0.924550	-0.591421	0
4.123429	0.970682	0.791785	0	4.203148	-0.809477	-0.484914	1
4.123179	1.077680	0.907129	0	4.203351	-0.574523	-0.278027	0
4.122871	1.183904	1.022484	0	4.203590	-0.334815	-0.077350	1
4.124050	-1.181150	-1.026516	0	4.203531	-0.090834	0.117988	0
4.124049	-1.183340	-1.023923	0	4.203542	0.157864	0.307231	1
4.124048	-1.185036	-1.020982	0	4.203168	0.412784	0.488597	0
4.124046	-1.186184	-1.017788	0	4.202616	0.675685	0.659738	1
4.124045	-1.186747	-1.014442	0	4.202148	0.947725	0.819189	0
4.124043	-1.186709	-1.011050	0	4.201906	1.087939	0.893546	0
4.124041	-1.186070	-1.007720	0	4.201542	1.232094	0.961557	0
4.124038	-1.184853	-1.004557	0	4.288418	-1.264055	-0.908821	0
4.124046	-1.171572	-0.978135	0	4.288418	-1.261945	-0.910915	0
4.124083	-1.150332	-0.942888	0	4.288418	-1.259490	-0.912590	0
4.124128	-1.103138	-0.877930	0	4.288418	-1.256769	-0.913787	0
4.124182	-1.052929	-0.816502	0	4.288417	-1.253877	-0.914469	0
4.124249	-1.001141	-0.756833	0	4.288417	-1.250909	-0.914611	0
4.124329	-0.894912	-0.640575	0	4.288417	-1.247964	-0.914209	0
4.124424	-0.786113	-0.527208	1	4.288417	-1.245141	-0.913278	0
4.124651	-0.563292	-0.306616	0	4.288415	-1.220531	-0.902562	0
4.124892	-0.335189	-0.092183	1	4.288410	-1.184691	-0.885645	0
4.124803	-0.102259	0.116960	0	4.288479	-1.115481	-0.840635	0
4.124812	0.135935	0.319988	1	4.288500	-1.047955	-0.808550	0
4.124438	0.381047	0.515160	0	4.288500	-0.981646	-0.767179	0
4.124003	0.634836	0.700407	1	4.288582	-0.849845	-0.683331	0
4.123447	0.899198	0.873503	0	4.288615	-0.719460	-0.597473	1
4.123182	1.036015	0.954756	0	4.288853	-0.460451	-0.423451	0
4.122880	1.177309	1.030004	0	4.289083	-0.204094	-0.245850	1
4.202869	-1.234109	-0.956799	0	4.288997	0.049870	-0.064814	0
4.202868	-1.231758	-0.958979	0	4.289042	0.301371	0.119557	1
4.202867	-1.229055	-0.960701	0	4.288544	0.550026	0.307947	0
4.202865	-1.226086	-0.961908	0	4.287976	0.794808	0.501537	1
4.202864	-1.222947	-0.962560	0	4.287516	1.034674	0.701930	0
4.202863	-1.219743	-0.962636	0	4.287303	1.152781	0.804648	0
4.202862	-1.216576	-0.962134	0	4.287014	1.270297	0.907100	0
4.202861	-1.213551	-0.961072	0	4.288418	-1.264055	-0.908821	0
4.202844	-1.189790	-0.950416	0	4.288419	-1.265746	-0.906376	0
4.202847	-1.154071	-0.932701	0	4.288419	-1.266963	-0.903663	0
4.202865	-1.085926	-0.893043	0	4.288419	-1.267665	-0.900774	0
4.202918	-1.019330	-0.851341	0	4.288420	-1.267829	-0.897804	0
4.202984	-0.953727	-0.808338	0	4.288420	-1.267449	-0.894854	0
4.203061	-0.824343	-0.720087	0	4.288420	-1.266537	-0.892023	0
4.203154	-0.696258	-0.630113	1	4.288420	-1.265126	-0.889405	0
4.203381	-0.442730	-0.446938	0	4.288420	-1.248270	-0.864221	0
4.203619	-0.192114	-0.260207	1	4.288462	-1.223173	-0.832258	0

TABLE A-III. — Continued. CM-2D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.288480	-1.169452	-0.773487	0	4.480895	-1.273797	-0.861598	0
4.288502	-1.113284	-0.718115	0	4.480895	-1.271403	-0.862199	0
4.288507	-1.056091	-0.664295	0	4.480895	-1.268940	-0.862339	0
4.288591	-0.938900	-0.560108	0	4.480895	-1.266494	-0.862016	0
4.288657	-0.819881	-0.458596	1	4.480895	-1.264153	-0.861238	0
4.288838	-0.577571	-0.261570	0	4.480895	-1.238182	-0.849799	0
4.289030	-0.330902	-0.070609	1	4.480918	-1.202584	-0.833314	0
4.288997	-0.080464	0.115192	0	4.480923	-1.134024	-0.796571	0
4.289048	0.174246	0.295128	1	4.480927	-1.066464	-0.758387	0
4.288604	0.434543	0.467346	0	4.480928	-0.999931	-0.718645	0
4.288045	0.702048	0.629708	1	4.480991	-0.867362	-0.638367	0
4.287473	0.977892	0.780469	0	4.481040	-0.735849	-0.556592	1
4.287305	1.119287	0.850908	0	4.481183	-0.474471	-0.390646	0
4.287015	1.264451	0.915182	0	4.481342	-0.214821	-0.222131	1
4.381122	-1.277451	-0.877751	0	4.481321	0.042894	-0.050744	0
4.381122	-1.275562	-0.879704	0	4.481311	0.298781	0.123384	1
4.381122	-1.273345	-0.881273	0	4.480861	0.552585	0.300735	0
4.381121	-1.270876	-0.882405	0	4.480303	0.803373	0.482381	1
4.381121	-1.268239	-0.883059	0	4.479856	1.050331	0.669677	0
4.381121	-1.265526	-0.883214	0	4.479660	1.172430	0.765359	0
4.381121	-1.262832	-0.882864	0	4.479379	1.294161	0.860434	0
4.381121	-1.260249	-0.882021	0	4.480895	-1.279733	-0.857327	0
4.381121	-1.234890	-0.871040	0	4.480895	-1.281062	-0.855248	0
4.381118	-1.199083	-0.854509	0	4.480896	-1.281977	-0.852957	0
4.381153	-1.129883	-0.817873	0	4.480896	-1.282446	-0.850535	0
4.381155	-1.062405	-0.778811	0	4.480896	-1.282452	-0.848068	0
4.381166	-0.995573	-0.738779	0	4.480896	-1.281994	-0.845644	0
4.381231	-0.862931	-0.657273	0	4.480896	-1.281088	-0.843348	0
4.381279	-0.731454	-0.574114	1	4.480896	-1.279771	-0.841262	0
4.381438	-0.470342	-0.405144	0	4.480896	-1.260573	-0.816599	0
4.381635	-0.211300	-0.233252	1	4.480919	-1.233871	-0.786925	0
4.381583	0.045633	-0.058204	0	4.480924	-1.177595	-0.731973	0
4.381584	0.300420	0.119922	1	4.480929	-1.119171	-0.680240	0
4.381150	0.552645	0.301782	0	4.480930	-1.060074	-0.629469	0
4.380573	0.801608	0.488289	1	4.480992	-0.939404	-0.531559	0
4.380120	1.046215	0.681070	0	4.481040	-0.817217	-0.435955	1
4.379922	1.166914	0.779767	0	4.481183	-0.569216	-0.250176	0
4.379630	1.287215	0.877966	0	4.481342	-0.317488	-0.069918	1
4.381122	-1.277451	-0.877751	0	4.481321	-0.062640	0.105719	0
4.381123	-1.278946	-0.875482	0	4.481312	0.195750	0.276131	1
4.381123	-1.279994	-0.872976	0	4.480862	0.458993	0.439492	0
4.381124	-1.280559	-0.870318	0	4.480308	0.727933	0.594224	1
4.381124	-1.280624	-0.867602	0	4.479858	1.003619	0.738926	0
4.381124	-1.280183	-0.864921	0	4.479661	1.144600	0.806621	0
4.381124	-1.279254	-0.862367	0	4.479379	1.288582	0.868703	0
4.381124	-1.277871	-0.860027	0	4.587817	-1.274505	-0.841444	0
4.381126	-1.259705	-0.835152	0	4.587817	-1.272979	-0.843077	0
4.381123	-1.233754	-0.804376	0	4.587817	-1.271169	-0.844390	0
4.381154	-1.178181	-0.748053	0	4.587817	-1.269144	-0.845334	0
4.381158	-1.120815	-0.694363	0	4.587817	-1.266975	-0.845876	0
4.381170	-1.062215	-0.642428	0	4.587817	-1.264744	-0.845996	0
4.381232	-0.942759	-0.541875	0	4.587817	-1.262530	-0.845691	0
4.381280	-0.821584	-0.443823	1	4.587817	-1.260414	-0.844971	0
4.381505	-0.575116	-0.253724	0	4.587816	-1.233969	-0.833018	0
4.381633	-0.324963	-0.068955	1	4.587815	-1.199007	-0.816154	0
4.381584	-0.071157	0.110614	0	4.587821	-1.130811	-0.779800	0
4.381587	0.186455	0.284647	1	4.587829	-1.063831	-0.741605	0
4.381157	0.449190	0.451318	0	4.587830	-0.997696	-0.702158	0
4.380573	0.718359	0.608619	1	4.587874	-0.865909	-0.622551	0
4.380125	0.994868	0.755287	0	4.587914	-0.734982	-0.541655	1
4.379929	1.136526	0.823691	0	4.588088	-0.474380	-0.378008	0
4.379630	1.281540	0.886169	0	4.588195	-0.215528	-0.211695	1
4.480895	-1.279733	-0.857327	0	4.588146	0.041888	-0.043142	0
4.480895	-1.278037	-0.859118	0	4.588104	0.297620	0.127922	1
4.480895	-1.276034	-0.860558	0	4.587718	0.551349	0.302003	0



TABLE A-III. — Continued. CM-2D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.587176	0.802563	0.479796	1	4.701883	-0.918985	-0.517398	0
4.586657	1.050570	0.662431	0	4.701912	-0.796868	-0.425413	1
4.586535	1.173090	0.755878	0	4.702052	-0.549296	-0.246527	0
4.586264	1.295594	0.848343	0	4.702137	-0.298717	-0.072158	1
4.587817	-1.274505	-0.841444	0	4.702089	-0.045161	0.097771	0
4.587817	-1.275693	-0.839551	0	4.702027	0.211335	0.263209	1
4.587818	-1.276500	-0.837466	0	4.701684	0.471769	0.422680	0
4.587818	-1.276893	-0.835266	0	4.701163	0.737194	0.574502	1
4.587818	-1.276864	-0.833032	0	4.700742	1.008289	0.717640	0
4.587818	-1.276409	-0.830843	0	4.700559	1.146513	0.785138	0
4.587818	-1.275546	-0.828781	0	4.700296	1.287422	0.847479	0
4.587818	-1.274307	-0.826921	0	4.830098	-1.244478	-0.812191	0
4.587817	-1.254290	-0.802433	0	4.830098	-1.243237	-0.813532	0
4.587816	-1.227403	-0.773415	0	4.830098	-1.241758	-0.814605	0
4.587821	-1.170358	-0.720282	0	4.830098	-1.240099	-0.815371	0
4.587830	-1.111679	-0.669589	0	4.830098	-1.238324	-0.815801	0
4.587830	-1.052305	-0.619971	0	4.830098	-1.236498	-0.815878	0
4.587875	-0.931330	-0.524093	0	4.830098	-1.234692	-0.815599	0
4.587890	-0.808988	-0.430252	1	4.830098	-1.232976	-0.814975	0
4.588088	-0.560460	-0.248457	0	4.830102	-1.205888	-0.802264	0
4.588194	-0.308842	-0.071259	1	4.830102	-1.172018	-0.785122	0
4.588146	-0.054069	0.101272	0	4.830104	-1.105707	-0.748634	0
4.588105	0.203887	0.268987	1	4.830103	-1.040566	-0.710390	0
4.587721	0.466126	0.430260	0	4.830110	-0.975766	-0.671628	0
4.587178	0.733767	0.583330	1	4.830133	-0.846817	-0.593092	0
4.586657	1.007786	0.726815	0	4.830161	-0.718570	-0.513515	1
4.586537	1.147401	0.794536	0	4.830262	-0.462764	-0.353254	0
4.586264	1.290072	0.856650	0	4.830327	-0.208295	-0.190933	1
4.701840	-1.263028	-0.827199	0	4.830314	0.044986	-0.026819	0
4.701840	-1.261649	-0.828683	0	4.830184	0.297216	0.139012	1
4.701840	-1.260012	-0.829874	0	4.829898	0.547850	0.307293	0
4.701840	-1.258175	-0.830729	0	4.829414	0.796268	0.478754	1
4.701840	-1.256209	-0.831215	0	4.829012	1.042099	0.654153	0
4.701840	-1.254185	-0.831313	0	4.828846	1.164159	0.743203	0
4.701840	-1.252180	-0.831022	0	4.828566	1.285959	0.831336	0
4.701840	-1.250269	-0.830351	0	4.830098	-1.244478	-0.812191	0
4.701841	-1.223496	-0.817913	0	4.830098	-1.245436	-0.810636	0
4.701836	-1.189023	-0.800916	0	4.830098	-1.246073	-0.808925	0
4.701843	-1.121662	-0.764463	0	4.830098	-1.246366	-0.807122	0
4.701843	-1.055556	-0.726128	0	4.830098	-1.246302	-0.805297	0
4.701845	-0.989871	-0.687141	0	4.830098	-1.245885	-0.803518	0
4.701882	-0.859245	-0.608078	0	4.830098	-1.245130	-0.801856	0
4.701911	-0.729369	-0.527871	1	4.830098	-1.244066	-0.800372	0
4.702052	-0.470641	-0.365915	0	4.830102	-1.222797	-0.776503	0
4.702137	-0.213419	-0.201630	1	4.830102	-1.195654	-0.749108	0
4.702088	0.042594	-0.035432	0	4.830104	-1.138634	-0.698467	0
4.702027	0.297106	0.133020	1	4.830103	-1.080416	-0.649676	0
4.701682	0.549821	0.304208	0	4.830110	-1.021256	-0.602320	0
4.701162	0.800308	0.478703	1	4.830133	-0.901342	-0.510020	0
4.700739	1.047725	0.657781	0	4.830161	-0.780189	-0.419637	1
4.700557	1.170375	0.748921	0	4.830263	-0.534596	-0.243814	0
4.700296	1.292913	0.839146	0	4.830327	-0.286229	-0.072197	1
4.701840	-1.263028	-0.827199	0	4.830315	-0.035236	0.095403	0
4.701840	-1.264096	-0.825477	0	4.830184	0.218760	0.258543	1
4.701840	-1.264812	-0.823583	0	4.829902	0.476266	0.416290	0
4.701840	-1.265150	-0.821586	0	4.829416	0.738362	0.566976	1
4.701840	-1.265099	-0.819561	0	4.829014	1.005729	0.709563	0
4.701840	-1.264659	-0.817585	0	4.828848	1.141963	0.777020	0
4.701840	-1.263847	-0.815729	0	4.828566	1.280484	0.839677	0
4.701840	-1.262694	-0.814065	0	4.986854	-1.214673	-0.794757	0
4.701841	-1.242039	-0.789769	0	4.986854	-1.213570	-0.795944	0
4.701839	-1.214897	-0.761631	0	4.986854	-1.212255	-0.796892	0
4.701843	-1.157759	-0.709672	0	4.986854	-1.210781	-0.797565	0
4.701843	-1.099233	-0.659830	0	4.986854	-1.209202	-0.797935	0
4.701845	-1.039727	-0.611462	0	4.986854	-1.207582	-0.797989	0



TABLE A-III. — Continued. CM-2D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.986854	-1.205983	-0.797723	0	5.163622	1.254286	0.819044	0
4.986854	-1.204467	-0.797150	0	5.164944	-1.173607	-0.776816	0
4.986855	-1.177375	-0.783961	0	5.164944	-1.174357	-0.775604	0
4.986855	-1.144334	-0.766672	0	5.164944	-1.174851	-0.774267	0
4.986851	-1.079503	-0.730163	0	5.164944	-1.175070	-0.772860	0
4.986851	-1.015728	-0.692073	0	5.164944	-1.175006	-0.771436	0
4.986857	-0.952248	-0.653539	0	5.164944	-1.174661	-0.770054	0
4.986871	-0.825815	-0.575643	0	5.164944	-1.174049	-0.768768	0
4.986894	-0.700007	-0.496825	1	5.164944	-1.173197	-0.767627	0
4.986964	-0.448846	-0.338412	0	5.164958	-1.151736	-0.744136	0
4.987008	-0.198829	-0.178243	1	5.164958	-1.125219	-0.718418	0
4.986995	0.050193	-0.016568	0	5.164950	-1.069846	-0.670473	0
4.986863	0.298371	0.146489	1	5.164950	-1.013478	-0.624047	0
4.986613	0.544995	0.311859	0	5.164957	-0.956343	-0.578780	0
4.986175	0.789877	0.479834	1	5.164965	-0.840660	-0.490352	0
4.985801	1.032379	0.651345	0	5.164986	-0.723958	-0.403481	1
4.985648	1.152923	0.738215	0	5.165030	-0.487546	-0.234171	0
4.985373	1.273236	0.824160	0	5.165056	-0.248768	-0.068420	1
4.986854	-1.214673	-0.794757	0	5.165006	-0.007455	0.093599	0
4.986854	-1.215521	-0.793376	0	5.164910	0.236077	0.252230	1
4.986854	-1.216081	-0.791856	0	5.164705	0.482645	0.406307	0
4.986854	-1.216331	-0.790255	0	5.164325	0.733015	0.554619	1
4.986854	-1.216264	-0.788637	0	5.163992	0.987707	0.696316	0
4.986854	-1.215878	-0.787064	0	5.163840	1.117155	0.763983	0
4.986854	-1.215194	-0.785596	0	5.163622	1.248769	0.827355	0
4.986854	-1.214233	-0.784291	0	5.342999	-1.125990	-0.759437	0
4.986855	-1.192643	-0.760743	0	5.342999	-1.125118	-0.760353	0
4.986855	-1.165681	-0.734206	0	5.342999	-1.124080	-0.761077	0
4.986851	-1.109244	-0.684930	0	5.342999	-1.122919	-0.761580	0
4.986852	-1.051732	-0.637318	0	5.342999	-1.121682	-0.761840	0
4.986857	-0.993355	-0.591021	0	5.342999	-1.120417	-0.761849	0
4.986871	-0.875101	-0.500685	0	5.342999	-1.119175	-0.761605	0
4.986894	-0.755722	-0.412093	1	5.342999	-1.118008	-0.761119	0
4.986964	-0.513830	-0.239579	0	5.342997	-1.091706	-0.746898	0
4.987008	-0.269375	-0.070953	1	5.343028	-1.060957	-0.729116	0
4.986995	-0.022472	0.093943	0	5.343019	-1.000083	-0.692585	0
4.986863	0.227244	0.254662	1	5.343019	-0.940021	-0.654867	0
4.986614	0.480122	0.410522	0	5.342999	-0.880103	-0.616923	0
4.986176	0.737190	0.559964	1	5.343037	-0.760984	-0.539998	0
4.985803	0.999072	0.702001	0	5.343044	-0.642119	-0.462683	1
4.985648	1.132381	0.769459	0	5.343082	-0.404797	-0.307417	0
4.985373	1.267753	0.832498	0	5.343102	-0.168194	-0.151061	1
5.164944	-1.173607	-0.776816	0	5.343056	0.068008	0.005966	0
5.164944	-1.172632	-0.777855	0	5.342991	0.303248	0.164371	1
5.164944	-1.171470	-0.778682	0	5.342808	0.537343	0.324477	0
5.164944	-1.170167	-0.779262	0	5.342491	0.770111	0.486529	1
5.164944	-1.168776	-0.779573	0	5.342200	1.000965	0.651323	0
5.164944	-1.167351	-0.779602	0	5.342060	1.115794	0.734580	0
5.164944	-1.165948	-0.779349	0	5.341873	1.230801	0.816592	0
5.164944	-1.164624	-0.778823	0	5.342999	-1.125990	-0.759437	0
5.164958	-1.137976	-0.764861	0	5.342999	-1.126660	-0.758365	0
5.164958	-1.105969	-0.747406	0	5.342999	-1.127103	-0.757181	0
5.164950	-1.043022	-0.710868	0	5.342999	-1.127302	-0.755934	0
5.164950	-0.980999	-0.672960	0	5.342999	-1.127247	-0.754671	0
5.164957	-0.919248	-0.634642	0	5.342999	-1.126938	-0.753445	0
5.164964	-0.796171	-0.557348	0	5.342999	-1.126393	-0.752306	0
5.164986	-0.673649	-0.479243	1	5.342999	-1.125631	-0.751298	0
5.165030	-0.428828	-0.322595	0	5.342997	-1.104264	-0.728307	0
5.165056	-0.184982	-0.164476	1	5.343029	-1.078528	-0.703103	0
5.165005	0.058296	-0.005415	0	5.343020	-1.024575	-0.656327	0
5.164911	0.300501	0.155214	1	5.343020	-0.969688	-0.610951	0
5.164705	0.541495	0.317684	0	5.343000	-0.913991	-0.566759	0
5.164323	0.780944	0.482441	1	5.343037	-0.801643	-0.479811	0
5.163990	1.018235	0.650343	0	5.343044	-0.688111	-0.394599	1
5.163839	1.136214	0.735281	0	5.343083	-0.458513	-0.227899	0

TABLE A-III. — Continued. CM-2D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
5.343102	-0.226588	-0.064620	1	5.698890	-0.943350	-0.691549	0
5.343056	0.007769	0.095140	0	5.699006	-0.888168	-0.654336	0
5.342991	0.244165	0.251834	1	5.698983	-0.832770	-0.617418	0
5.342808	0.483286	0.404498	0	5.698977	-0.777943	-0.579721	0
5.342492	0.725958	0.551889	1	5.699049	-0.668661	-0.503788	0
5.342202	0.972625	0.693274	0	5.699005	-0.559013	-0.428351	1
5.342060	1.097888	0.761088	0	5.699068	-0.341002	-0.275684	0
5.341874	1.225216	0.824860	0	5.699172	-0.123722	-0.121975	1
5.520997	-1.069756	-0.742814	0	5.699172	0.093724	0.031552	0
5.520997	-1.068966	-0.743623	0	5.699158	0.310326	0.186221	1
5.520997	-1.068031	-0.744258	0	5.699071	0.525944	0.342271	0
5.520997	-1.066986	-0.744691	0	5.698949	0.740926	0.499241	1
5.520997	-1.065876	-0.744907	0	5.698720	0.953852	0.658954	0
5.520997	-1.064746	-0.744895	0	5.698614	1.059684	0.739647	0
5.520997	-1.063641	-0.744656	0	5.698503	1.166060	0.818725	0
5.520996	-1.062608	-0.744199	0	5.698927	-1.003079	-0.722405	0
5.520993	-1.036977	-0.729656	0	5.698927	-1.003640	-0.721558	0
5.520986	-1.007276	-0.712038	0	5.698927	-1.004018	-0.720615	0
5.521042	-0.949020	-0.675144	0	5.698927	-1.004198	-0.719615	0
5.521040	-0.891214	-0.637605	0	5.698927	-1.004172	-0.718600	0
5.521014	-0.833531	-0.599880	0	5.698927	-1.003943	-0.717611	0
5.521063	-0.718932	-0.523341	0	5.698927	-1.003517	-0.716689	0
5.521073	-0.604495	-0.446558	1	5.698927	-1.002913	-0.715871	0
5.521117	-0.375981	-0.292438	0	5.698923	-0.982730	-0.693730	0
5.521140	-0.148046	-0.137464	1	5.698890	-0.958484	-0.670458	0
5.521111	0.079609	0.017976	0	5.699007	-0.909287	-0.624906	0
5.521066	0.306367	0.174664	1	5.698985	-0.858365	-0.581748	0
5.520933	0.532072	0.332880	0	5.698977	-0.807189	-0.538963	0
5.520684	0.756616	0.492755	1	5.699051	-0.703791	-0.454832	0
5.520442	0.979454	0.655015	0	5.699006	-0.598769	-0.372946	1
5.520317	1.090320	0.736915	0	5.699136	-0.387867	-0.210374	0
5.520166	1.201448	0.817508	0	5.699172	-0.174360	-0.051404	1
5.520997	-1.069756	-0.742814	0	5.699172	0.041407	0.104460	0
5.520997	-1.070366	-0.741863	0	5.699158	0.258904	0.257884	1
5.520997	-1.070773	-0.740809	0	5.699070	0.478738	0.408059	0
5.520997	-1.070960	-0.739694	0	5.698951	0.702143	0.553288	1
5.520997	-1.070919	-0.738565	0	5.698785	0.928667	0.694069	0
5.520997	-1.070651	-0.737467	0	5.698615	1.043318	0.762456	0
5.520997	-1.070168	-0.736446	0	5.698504	1.160247	0.826825	0
5.520997	-1.069491	-0.735542	0	5.876818	-0.926325	-0.694133	0
5.520994	-1.048584	-0.712928	0	5.876818	-0.925591	-0.694839	0
5.521029	-1.023643	-0.688453	0	5.876818	-0.924730	-0.695382	0
5.521043	-0.971673	-0.642500	0	5.876818	-0.923776	-0.695740	0
5.521042	-0.918662	-0.598050	0	5.876818	-0.922769	-0.695897	0
5.521015	-0.864888	-0.554693	0	5.876818	-0.921751	-0.695849	0
5.521065	-0.756574	-0.469098	0	5.876818	-0.920764	-0.695595	0
5.521075	-0.647092	-0.385175	1	5.876817	-0.919850	-0.695148	0
5.521118	-0.425763	-0.220700	0	5.876793	-0.896419	-0.680979	0
5.521140	-0.202205	-0.059420	1	5.876784	-0.869608	-0.663646	0
5.521111	0.023697	0.098547	0	5.876801	-0.817087	-0.627496	0
5.521067	0.251473	0.253772	1	5.876843	-0.764944	-0.590831	0
5.520932	0.481765	0.405376	0	5.876894	-0.713206	-0.553622	0
5.520686	0.715402	0.552145	1	5.876927	-0.609828	-0.479084	0
5.520444	0.952791	0.693436	0	5.876979	-0.506504	-0.404463	1
5.520317	1.073274	0.761480	0	5.877074	-0.300444	-0.254421	0
5.520166	1.195758	0.825706	0	5.877181	-0.094647	-0.103976	1
5.698927	-1.003079	-0.722405	0	5.877248	0.110628	0.047173	0
5.698927	-1.002359	-0.723121	0	5.877265	0.315539	0.198798	1
5.698927	-1.001509	-0.723678	0	5.877244	0.519929	0.351154	0
5.698927	-1.000565	-0.724051	0	5.877179	0.723052	0.505183	1
5.698927	-0.999563	-0.724225	0	5.877070	0.924760	0.661066	0
5.698927	-0.998549	-0.724194	0	5.876985	1.025317	0.739392	0
5.698927	-0.997561	-0.723959	0	5.876870	1.125748	0.817014	0
5.698927	-0.996640	-0.723530	0	5.876818	-0.926325	-0.694133	0
5.698923	-0.971917	-0.708799	0	5.876818	-0.926900	-0.693293	0



TABLE A-III. — Continued. CM-2D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
5.876818	-0.927293	-0.692354	0	6.055412	0.472216	0.413776	0
5.876818	-0.927487	-0.691356	0	6.055412	0.670000	0.553596	1
5.876818	-0.927476	-0.690338	0	6.055369	0.870918	0.689306	0
5.876818	-0.927257	-0.689345	0	6.055309	0.972959	0.755096	0
5.876818	-0.926842	-0.688417	0	6.055269	1.076449	0.818197	0
5.876818	-0.926246	-0.687592	0	6.232576	-0.752225	-0.610881	0
5.876793	-0.907083	-0.666638	0	6.232575	-0.751467	-0.611567	0
5.876785	-0.884288	-0.643906	0	6.232575	-0.750585	-0.612086	0
5.876802	-0.837313	-0.600295	0	6.232575	-0.749616	-0.612416	0
5.876919	-0.789633	-0.557618	0	6.232575	-0.748599	-0.612543	0
5.876894	-0.740949	-0.516313	0	6.232575	-0.747578	-0.612462	0
5.877015	-0.643455	-0.433852	0	6.232575	-0.746596	-0.612176	0
5.876980	-0.544001	-0.354036	1	6.232575	-0.745694	-0.611697	0
5.877074	-0.344187	-0.195594	0	6.232573	-0.725779	-0.598393	0
5.877179	-0.142197	-0.040030	1	6.232575	-0.702494	-0.581911	0
5.877248	0.061520	0.113214	0	6.232612	-0.656876	-0.547744	0
5.877266	0.267270	0.263713	1	6.232656	-0.611315	-0.513513	0
5.877244	0.475587	0.410787	0	6.232761	-0.566360	-0.478497	0
5.877181	0.686517	0.554317	1	6.232826	-0.476085	-0.408966	0
5.877076	0.900761	0.693342	0	6.232936	-0.386430	-0.338626	1
5.876986	1.009583	0.760552	0	6.233107	-0.206987	-0.198126	0
5.876871	1.119799	0.825014	0	6.233277	-0.027354	-0.057859	1
6.054683	-0.841694	-0.656592	0	6.233398	0.151626	0.083246	0
6.054683	-0.840948	-0.657288	0	6.233526	0.330222	0.224871	1
6.054683	-0.840075	-0.657819	0	6.233589	0.508271	0.367147	0
6.054683	-0.839113	-0.658164	0	6.233646	0.685509	0.510438	1
6.054682	-0.838100	-0.658307	0	6.233655	0.861645	0.655084	0
6.054682	-0.837080	-0.658242	0	6.233628	0.949444	0.727742	0
6.054682	-0.836094	-0.657973	0	6.233618	1.037369	0.799497	0
6.054682	-0.835183	-0.657512	0	6.232576	-0.752225	-0.610881	0
6.054677	-0.813544	-0.643596	0	6.232576	-0.752827	-0.610056	0
6.054675	-0.788464	-0.626591	0	6.232576	-0.753248	-0.609126	0
6.054704	-0.739319	-0.591260	0	6.232576	-0.753472	-0.608132	0
6.054751	-0.690425	-0.555598	0	6.232576	-0.753487	-0.607112	0
6.054823	-0.641966	-0.519365	0	6.232576	-0.753294	-0.606112	0
6.054867	-0.544837	-0.447194	0	6.232575	-0.752900	-0.605173	0
6.054953	-0.448331	-0.374200	1	6.232575	-0.752324	-0.604331	0
6.055086	-0.255254	-0.228293	0	6.232574	-0.736161	-0.585333	0
6.055235	-0.062370	-0.082093	1	6.232579	-0.716333	-0.564505	0
6.055334	0.130081	0.064676	0	6.232615	-0.675477	-0.524344	0
6.055390	0.322459	0.211534	1	6.232655	-0.633460	-0.485658	0
6.055411	0.513925	0.359566	0	6.232764	-0.591432	-0.446960	0
6.055411	0.704463	0.508805	1	6.232826	-0.505815	-0.371571	0
6.055365	0.893749	0.659634	0	6.232939	-0.419877	-0.296553	1
6.055308	0.988119	0.735392	0	6.233107	-0.245785	-0.149325	0
6.055264	1.082522	0.810305	0	6.233275	-0.069395	-0.004979	1
6.054683	-0.841694	-0.656592	0	6.233395	0.108274	0.137772	0
6.054683	-0.842283	-0.655760	0	6.233527	0.287584	0.278504	1
6.054683	-0.842690	-0.654826	0	6.233589	0.469009	0.416532	0
6.054683	-0.842897	-0.653830	0	6.233647	0.652975	0.551361	1
6.054683	-0.842898	-0.652813	0	6.233657	0.839896	0.682439	0
6.054682	-0.842691	-0.651817	0	6.233686	0.935056	0.745812	0
6.054682	-0.842285	-0.650884	0	6.233620	1.031165	0.807301	0
6.054682	-0.841700	-0.650050	0	6.410501	-0.658844	-0.557615	0
6.054677	-0.824069	-0.629917	0	6.410501	-0.658076	-0.558291	0
6.054677	-0.802713	-0.608072	0	6.410501	-0.657186	-0.558798	0
6.054707	-0.758713	-0.566054	0	6.410501	-0.656211	-0.559115	0
6.054749	-0.713638	-0.525429	0	6.410501	-0.655192	-0.559227	0
6.054825	-0.668330	-0.485099	0	6.410501	-0.654172	-0.559132	0
6.054867	-0.576241	-0.406377	0	6.410501	-0.653193	-0.558833	0
6.054955	-0.483734	-0.328186	1	6.410501	-0.652298	-0.558339	0
6.055086	-0.296439	-0.174765	0	6.410500	-0.634152	-0.545815	0
6.055233	-0.107074	-0.023992	1	6.410505	-0.612705	-0.530041	0
6.055334	0.083937	0.124648	0	6.410560	-0.570291	-0.497920	0
6.055390	0.277124	0.270456	1	6.410593	-0.528612	-0.464881	0



TABLE A-III. — Continued. CM-2D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
6.410728	-0.487280	-0.431393	0	6.588470	-0.561150	-0.490880	0
6.410808	-0.404076	-0.365149	0	6.588470	-0.560782	-0.489930	0
6.410941	-0.321529	-0.298055	1	6.588470	-0.560229	-0.489073	0
6.411160	-0.155780	-0.164731	0	6.588469	-0.547154	-0.472800	0
6.411346	0.009360	-0.030625	1	6.588474	-0.530570	-0.454441	0
6.411500	0.174347	0.103666	0	6.588538	-0.495981	-0.419429	0
6.411675	0.338895	0.238537	1	6.588568	-0.461002	-0.384848	0
6.411794	0.503295	0.373502	0	6.588724	-0.425972	-0.350286	0
6.411884	0.666351	0.510192	1	6.588813	-0.354141	-0.283368	0
6.411942	0.828763	0.647586	0	6.588968	-0.282257	-0.216432	1
6.411991	0.909958	0.716263	0	6.589227	-0.135927	-0.085696	0
6.411952	0.990804	0.784753	0	6.589438	0.011627	0.043635	1
6.410501	-0.658844	-0.557615	0	6.589620	0.160681	0.171194	0
6.410501	-0.659459	-0.556797	0	6.589846	0.311291	0.296926	1
6.410501	-0.659894	-0.555873	0	6.589990	0.463569	0.420672	0
6.410501	-0.660132	-0.554880	0	6.590140	0.618017	0.541854	1
6.410502	-0.660161	-0.553861	0	6.590243	0.774944	0.660095	0
6.410502	-0.659983	-0.552858	0	6.590288	0.854655	0.717744	0
6.410502	-0.659603	-0.551912	0	6.590279	0.935394	0.773601	0
6.410502	-0.659038	-0.551063	0	6.766477	-0.451745	-0.420857	0
6.410502	-0.644386	-0.533338	0	6.766477	-0.450958	-0.421518	0
6.410509	-0.626143	-0.513658	0	6.766476	-0.450054	-0.422006	0
6.410564	-0.588127	-0.476178	0	6.766476	-0.449069	-0.422303	0
6.410594	-0.549736	-0.439131	0	6.766475	-0.448046	-0.422395	0
6.410733	-0.511125	-0.402323	0	6.766475	-0.447026	-0.422280	0
6.410809	-0.432220	-0.330842	0	6.766474	-0.446053	-0.421961	0
6.410946	-0.353123	-0.259541	1	6.766474	-0.445166	-0.421454	0
6.411162	-0.192300	-0.120213	0	6.766467	-0.430821	-0.411123	0
6.411345	-0.030170	0.017558	1	6.766505	-0.413063	-0.397782	0
6.411498	0.133591	0.153343	0	6.766555	-0.378893	-0.369453	0
6.411676	0.298806	0.287404	1	6.766602	-0.344904	-0.340934	0
6.411795	0.466357	0.418529	0	6.766684	-0.311009	-0.312312	0
6.411885	0.635637	0.547630	1	6.766861	-0.243742	-0.254431	0
6.411942	0.808034	0.672853	0	6.767049	-0.176408	-0.176646	1
6.411992	0.895834	0.733480	0	6.767323	-0.042108	-0.080622	0
6.411952	0.984476	0.792467	0	6.767562	0.092101	0.035502	1
6.588469	-0.559943	-0.495624	0	6.767770	0.226192	0.151751	0
6.588469	-0.559165	-0.496290	0	6.768009	0.360018	0.268316	1
6.588469	-0.558267	-0.496786	0	6.768178	0.493281	0.385529	0
6.588468	-0.557287	-0.497090	0	6.768339	0.625891	0.503475	1
6.588468	-0.556266	-0.497191	0	6.768506	0.757759	0.622262	0
6.588468	-0.555247	-0.497083	0	6.768563	0.823392	0.682011	0
6.588467	-0.554272	-0.496771	0	6.768604	0.889200	0.740996	0
6.588467	-0.553381	-0.496269	0	6.766477	-0.451745	-0.420857	0
6.588464	-0.537076	-0.484708	0	6.766478	-0.452382	-0.420054	0
6.588467	-0.517542	-0.469836	0	6.766478	-0.452842	-0.419139	0
6.588531	-0.478938	-0.439566	0	6.766478	-0.453105	-0.418152	0
6.588566	-0.440938	-0.408554	0	6.766478	-0.453162	-0.417134	0
6.588715	-0.403381	-0.376983	0	6.766478	-0.453010	-0.416126	0
6.588810	-0.327632	-0.314686	0	6.766478	-0.452655	-0.415171	0
6.588960	-0.252558	-0.251528	1	6.766478	-0.452112	-0.414310	0
6.589223	-0.101735	-0.126094	0	6.766475	-0.440713	-0.399783	0
6.589439	0.048585	-0.000027	1	6.766521	-0.425576	-0.383441	0
6.589623	0.198776	0.126186	0	6.766562	-0.395018	-0.350977	0
6.589843	0.348756	0.252662	1	6.766601	-0.363746	-0.319347	0
6.589989	0.498138	0.379831	0	6.766687	-0.332117	-0.288121	0
6.590141	0.646860	0.507777	1	6.766863	-0.268375	-0.226209	0
6.590245	0.794619	0.636852	0	6.767069	-0.203900	-0.165142	1
6.590288	0.868265	0.701665	0	6.767329	-0.073647	-0.044488	0
6.590280	0.941848	0.765974	0	6.767560	0.058073	0.074487	1
6.588469	-0.559943	-0.495624	0	6.767762	0.191122	0.191935	0
6.588469	-0.560570	-0.494814	0	6.768013	0.325524	0.307842	1
6.588469	-0.561018	-0.493895	0	6.768179	0.461411	0.422041	0
6.588470	-0.561270	-0.492906	0	6.768335	0.599172	0.534086	1
6.588470	-0.561315	-0.491886	0	6.768500	0.739279	0.643439	0

TABLE A-III. — Concluded. CM-2D FORWARD COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
6.768562	0.810381	0.696917	0	7.123652	0.110951	0.043441	0
6.768602	0.882622	0.748534	0	7.123883	0.205651	0.129964	1
6.944635	-0.328032	-0.327575	0	7.124080	0.299908	0.216962	0
6.944634	-0.327243	-0.328232	0	7.124277	0.393671	0.304490	1
6.944633	-0.326339	-0.328718	0	7.124479	0.486767	0.392733	0
6.944632	-0.325355	-0.329011	0	7.124755	0.579031	0.481872	1
6.944631	-0.324333	-0.329101	0	7.124943	0.670207	0.572166	0
6.944630	-0.323316	-0.328983	0	7.124995	0.715327	0.617813	0
6.944629	-0.322345	-0.328663	0	7.125082	0.759801	0.663820	0
6.944628	-0.321460	-0.328153	0	7.122896	-0.182300	-0.206212	0
6.944618	-0.309326	-0.319348	0	7.122898	-0.182919	-0.205392	0
6.944627	-0.294184	-0.307140	0	7.122899	-0.183362	-0.204467	0
6.944686	-0.264558	-0.281986	0	7.122900	-0.183609	-0.203473	0
6.944783	-0.235112	-0.256651	0	7.122900	-0.183650	-0.202451	0
6.944814	-0.205514	-0.231534	0	7.122901	-0.183484	-0.201445	0
6.944993	-0.147513	-0.179807	0	7.122902	-0.183118	-0.200494	0
6.945178	-0.089316	-0.128352	1	7.122902	-0.182567	-0.199640	0
6.945457	0.026785	-0.025093	0	7.122910	-0.175147	-0.190354	0
6.945709	0.142761	0.078293	1	7.122963	-0.164375	-0.178389	0
6.945961	0.258777	0.181585	0	7.123017	-0.141940	-0.155489	0
6.946169	0.374012	0.285847	1	7.123050	-0.119424	-0.132616	0
6.946365	0.488877	0.390485	0	7.123075	-0.096728	-0.109940	0
6.946552	0.603128	0.495784	1	7.123257	-0.051157	-0.064767	0
6.946778	0.716831	0.601631	0	7.123312	-0.005201	-0.020016	1
6.946818	0.773022	0.655374	0	7.123654	0.087121	0.069068	0
6.946877	0.829487	0.708268	0	7.123878	0.180134	0.157403	1
6.944635	-0.328032	-0.327575	0	7.124082	0.273713	0.245131	0
6.944636	-0.328671	-0.326773	0	7.124279	0.367862	0.332244	1
6.944637	-0.329135	-0.325860	0	7.124475	0.462728	0.418584	0
6.944638	-0.329404	-0.324874	0	7.124756	0.558508	0.503943	1
6.944638	-0.329467	-0.323856	0	7.124942	0.655306	0.588191	0
6.944638	-0.329321	-0.322847	0	7.124993	0.704139	0.629845	0
6.944638	-0.328973	-0.321890	0	7.125069	0.752946	0.671202	0
6.944638	-0.328438	-0.321024	0				
6.944637	-0.318922	-0.308682	0				
6.944648	-0.306055	-0.293949	0				
6.944692	-0.279507	-0.265384	0				
6.944783	-0.252417	-0.237430	0				
6.944816	-0.224683	-0.210254	0				
6.944989	-0.169798	-0.155059	0				
6.945200	-0.114072	-0.100851	1				
6.945462	-0.001445	0.006256	0				
6.945702	0.112374	0.112040	1				
6.945957	0.227588	0.216211	0				
6.946181	0.343211	0.320064	1				
6.946366	0.460374	0.422137	0				
6.946544	0.579063	0.522505	1				
6.946776	0.699907	0.620418	0				
6.946816	0.760778	0.668968	0				
6.946871	0.822772	0.715728	0				
7.122896	-0.182300	-0.206212	0				
7.122895	-0.181528	-0.206891	0				
7.122894	-0.180637	-0.207402	0				
7.122893	-0.179663	-0.207725	0				
7.122892	-0.178645	-0.207843	0				
7.122891	-0.177628	-0.207754	0				
7.122891	-0.176653	-0.207461	0				
7.122891	-0.175758	-0.206975	0				
7.122896	-0.165989	-0.200218	0				
7.122948	-0.153443	-0.190156	0				
7.123014	-0.128590	-0.169846	0				
7.123051	-0.104234	-0.148951	0				
7.123071	-0.080019	-0.127908	0				
7.123260	-0.032026	-0.085340	0				
7.123315	0.015848	-0.042654	1				



TABLE A-IV. — CM-2D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 21; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.124273	-1.344298	0.800760	0	4.203555	0.313162	-0.088320	1
4.124273	-1.342116	0.803355	0	4.203201	0.576051	-0.257499	0
4.124273	-1.339506	0.805520	0	4.202731	0.834996	-0.433169	1
4.124273	-1.336555	0.807187	0	4.202416	1.089190	-0.616709	0
4.124273	-1.333354	0.808304	0	4.202294	1.214574	-0.711376	0
4.124273	-1.330006	0.808832	0	4.202099	1.339122	-0.806148	0
4.124273	-1.326617	0.808758	0	4.202983	-1.335596	0.808962	0
4.124273	-1.323296	0.808084	0	4.202983	-1.337210	0.806187	0
4.124273	-1.298763	0.800783	0	4.202983	-1.338299	0.803167	0
4.124274	-1.260802	0.788036	0	4.202983	-1.338826	0.800000	0
4.124280	-1.187849	0.757565	0	4.202983	-1.338776	0.796792	0
4.124298	-1.116458	0.724468	0	4.202983	-1.338151	0.793643	0
4.124318	-1.045924	0.689938	0	4.202983	-1.336969	0.790659	0
4.124357	-0.906334	0.618429	0	4.202983	-1.335273	0.787935	0
4.124410	-0.767886	0.545021	1	4.202983	-1.317142	0.764179	0
4.124604	-0.493308	0.394463	0	4.203000	-1.290047	0.733493	0
4.124883	-0.221156	0.239986	1	4.203022	-1.232147	0.678290	0
4.124837	0.048797	0.081529	0	4.203026	-1.172184	0.626505	0
4.124823	0.316270	-0.080977	1	4.203045	-1.110955	0.576794	0
4.124462	0.580483	-0.248967	0	4.203089	-0.986374	0.480875	0
4.124007	0.840541	-0.423925	1	4.203138	-0.859856	0.388162	1
4.123682	1.095591	-0.607287	0	4.203330	-0.602781	0.209513	0
4.123537	1.221245	-0.702105	0	4.203610	-0.341563	0.037819	1
4.123341	1.345952	-0.797197	0	4.203544	-0.076440	-0.127775	0
4.124273	-1.344298	0.800760	0	4.203598	0.192667	-0.286747	1
4.124273	-1.345985	0.797819	0	4.203207	0.466832	-0.437379	0
4.124273	-1.347123	0.794625	0	4.202739	0.747330	-0.577590	1
4.124273	-1.347675	0.791278	0	4.202425	1.035488	-0.705188	0
4.124273	-1.347624	0.787888	0	4.202294	1.183113	-0.763162	0
4.124273	-1.346972	0.784560	0	4.202099	1.333944	-0.814673	0
4.124273	-1.345739	0.781401	0	4.288474	-1.325160	0.817017	0
4.124273	-1.343965	0.778511	0	4.288474	-1.323208	0.819259	0
4.124273	-1.326179	0.754902	0	4.288474	-1.320880	0.821108	0
4.124274	-1.299083	0.723982	0	4.288474	-1.318253	0.822500	0
4.124281	-1.241140	0.668391	0	4.288474	-1.315418	0.823390	0
4.124299	-1.180916	0.616608	0	4.288474	-1.312467	0.823748	0
4.124319	-1.119455	0.566895	0	4.288474	-1.309500	0.823561	0
4.124358	-0.994359	0.471138	0	4.288474	-1.306617	0.822839	0
4.124412	-0.867245	0.378762	1	4.288474	-1.281281	0.813935	0
4.124607	-0.608887	0.201065	0	4.288473	-1.244280	0.799649	0
4.124883	-0.346275	0.030627	1	4.288482	-1.172816	0.766997	0
4.124837	-0.079662	-0.133420	0	4.288517	-1.102767	0.731991	0
4.124823	0.191060	-0.290491	1	4.288517	-1.033623	0.695564	0
4.124465	0.467012	-0.438840	0	4.288568	-0.896358	0.621096	0
4.124007	0.749499	-0.576268	1	4.288624	-0.760161	0.544882	1
4.123683	1.039923	-0.700442	0	4.288806	-0.489753	0.389301	0
4.123540	1.188784	-0.756425	0	4.289101	-0.221404	0.230464	1
4.123343	1.340840	-0.805758	0	4.289037	0.044982	0.068239	0
4.202983	-1.335596	0.808962	0	4.289086	0.309243	-0.097368	1
4.202983	-1.333509	0.811401	0	4.288687	0.570760	-0.267553	0
4.202983	-1.331019	0.813426	0	4.288264	0.828514	-0.443687	1
4.202982	-1.328206	0.814971	0	4.287884	1.081779	-0.626968	0
4.202982	-1.325160	0.815983	0	4.287810	1.206846	-0.721278	0
4.202982	-1.321981	0.816432	0	4.287611	1.331108	-0.815528	0
4.202982	-1.318775	0.816302	0	4.288474	-1.325160	0.817017	0
4.202982	-1.315644	0.815600	0	4.288474	-1.326670	0.814457	0
4.202982	-1.290773	0.807588	0	4.288474	-1.327689	0.811664	0
4.202994	-1.253211	0.794152	0	4.288474	-1.328180	0.808732	0
4.203012	-1.180855	0.762757	0	4.288474	-1.328129	0.805760	0
4.203019	-1.110160	0.728620	0	4.288474	-1.327535	0.802848	0
4.203023	-1.040236	0.693246	0	4.288474	-1.326422	0.800092	0
4.203081	-0.901673	0.620329	0	4.288474	-1.324825	0.797584	0
4.203135	-0.764253	0.545568	1	4.288474	-1.306173	0.773678	0
4.203310	-0.491546	0.392603	0	4.288474	-1.279047	0.743422	0
4.203596	-0.221132	0.236042	1	4.288508	-1.221189	0.688700	0
4.203544	0.047219	0.075765	0	4.288517	-1.161316	0.637301	0

TABLE A-IV. — Continued. CM-2D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.288517	-1.100421	0.587531	0	4.480816	-1.286040	0.836699	0
4.288594	-0.976275	0.491811	0	4.480816	-1.283587	0.836429	0
4.288593	-0.850527	0.398676	1	4.480816	-1.281230	0.835703	0
4.288809	-0.594828	0.219374	0	4.480815	-1.255012	0.824843	0
4.289102	-0.335197	0.046438	1	4.480819	-1.219188	0.809045	0
4.289037	-0.071897	-0.120781	0	4.480828	-1.149912	0.773710	0
4.289085	0.195251	-0.281720	1	4.480863	-1.081746	0.736622	0
4.288690	0.467356	-0.434780	0	4.480863	-1.014348	0.698368	0
4.288265	0.745406	-0.578094	1	4.480922	-0.880368	0.620628	0
4.287886	1.030717	-0.709557	0	4.480974	-0.747278	0.541487	1
4.287813	1.176814	-0.769851	0	4.481141	-0.482677	0.380766	0
4.287611	1.325863	-0.824011	0	4.481343	-0.219674	0.217512	1
4.381074	-1.312330	0.824758	0	4.481364	0.041680	0.051649	0
4.381074	-1.310524	0.826791	0	4.481383	0.301332	-0.116871	1
4.381074	-1.308376	0.828455	0	4.481054	0.558761	-0.288985	0
4.381074	-1.305956	0.829692	0	4.480667	0.813049	-0.465841	1
4.381074	-1.303349	0.830461	0	4.480368	1.063625	-0.648415	0
4.381074	-1.300645	0.830732	0	4.480240	1.187594	-0.741748	0
4.381074	-1.297938	0.830499	0	4.480046	1.311053	-0.834667	0
4.381074	-1.295321	0.829768	0	4.480816	-1.296721	0.831444	0
4.381074	-1.269510	0.819888	0	4.480816	-1.298005	0.829337	0
4.381088	-1.233086	0.804781	0	4.480817	-1.298870	0.827025	0
4.381108	-1.162616	0.770821	0	4.480817	-1.299286	0.824593	0
4.381116	-1.093571	0.734598	0	4.480817	-1.299237	0.822125	0
4.381120	-1.025171	0.697372	0	4.480817	-1.298726	0.819711	0
4.381186	-0.889481	0.621127	0	4.480817	-1.297771	0.817436	0
4.381239	-0.754737	0.543402	1	4.480817	-1.296408	0.815379	0
4.381474	-0.486965	0.385319	0	4.480816	-1.276671	0.791142	0
4.381641	-0.221120	0.224098	1	4.480820	-1.249447	0.761965	0
4.381626	0.043024	0.060073	0	4.480829	-1.192041	0.708159	0
4.381652	0.305210	-0.107030	1	4.480864	-1.132719	0.657312	0
4.381322	0.564826	-0.278268	0	4.480864	-1.072516	0.607864	0
4.380891	0.821070	-0.454772	1	4.480922	-0.950034	0.512236	0
4.380588	1.073230	-0.637722	0	4.480976	-0.825958	0.419072	1
4.380461	1.197849	-0.731532	0	4.481143	-0.574289	0.238232	0
4.380281	1.321935	-0.825051	0	4.481344	-0.318947	0.063060	1
4.381074	-1.312330	0.824758	0	4.481364	-0.060361	-0.107112	0
4.381074	-1.313726	0.822426	0	4.481383	0.201718	-0.271857	1
4.381074	-1.314666	0.819876	0	4.481056	0.468270	-0.429777	0
4.381075	-1.315118	0.817195	0	4.480668	0.740118	-0.579312	1
4.381075	-1.315067	0.814478	0	4.480371	1.018473	-0.718672	0
4.381075	-1.314513	0.811818	0	4.480242	1.160688	-0.783613	0
4.381075	-1.313477	0.809306	0	4.480046	1.305662	-0.843056	0
4.381075	-1.311996	0.807027	0	4.587662	-1.277611	0.836912	0
4.381074	-1.292780	0.782954	0	4.587662	-1.276093	0.838554	0
4.381089	-1.265589	0.753192	0	4.587662	-1.274292	0.839877	0
4.381110	-1.207867	0.699001	0	4.587662	-1.272270	0.840833	0
4.381117	-1.148315	0.647708	0	4.587662	-1.270105	0.841388	0
4.381121	-1.087637	0.598226	0	4.587662	-1.267874	0.841520	0
4.381187	-0.964280	0.502409	0	4.587662	-1.265658	0.841226	0
4.381240	-0.839201	0.409343	1	4.587662	-1.263538	0.840518	0
4.381477	-0.585279	0.229282	0	4.587662	-1.237023	0.828715	0
4.381642	-0.327621	0.055070	1	4.587661	-1.201963	0.812048	0
4.381626	-0.066406	-0.113606	0	4.587703	-1.133811	0.775691	0
4.381651	0.198437	-0.276493	1	4.587712	-1.066756	0.737700	0
4.381322	0.467908	-0.432090	0	4.587712	-1.000402	0.698630	0
4.380895	0.743075	-0.578566	1	4.587784	-0.868464	0.619311	0
4.380590	1.025137	-0.714062	0	4.587795	-0.737273	0.538871	1
4.380462	1.169390	-0.776703	0	4.588043	-0.476223	0.375990	0
4.380281	1.316620	-0.833489	0	4.588191	-0.216686	0.210726	1
4.480816	-1.296721	0.831444	0	4.588192	0.041526	0.043352	0
4.480816	-1.295065	0.833274	0	4.588194	0.298145	-0.126427	1
4.480816	-1.293095	0.834759	0	4.587929	0.552635	-0.299473	0
4.480816	-1.290880	0.835849	0	4.587554	0.804387	-0.476619	1
4.480816	-1.288500	0.836503	0	4.587230	1.052884	-0.658723	0



TABLE A-IV. — Continued. CM-2D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.587140	1.175808	-0.751705	0	4.701993	-0.546867	0.251933	0
4.586978	1.298556	-0.843953	0	4.702126	-0.298046	0.075012	1
4.587662	-1.277611	0.836912	0	4.702140	-0.046140	-0.097391	0
4.587662	-1.278788	0.835012	0	4.702135	0.208834	-0.265199	1
4.587662	-1.279582	0.832923	0	4.701919	0.467680	-0.427266	0
4.587662	-1.279965	0.830721	0	4.701584	0.731375	-0.582043	1
4.587662	-1.279922	0.828486	0	4.701318	1.000856	-0.728110	0
4.587662	-1.279455	0.826301	0	4.701204	1.138335	-0.797052	0
4.587662	-1.278581	0.824243	0	4.701047	1.278453	-0.860998	0
4.587662	-1.277332	0.822390	0	4.829860	-1.225249	0.841203	0
4.587662	-1.257175	0.798013	0	4.829860	-1.223978	0.842517	0
4.587661	-1.230123	0.769141	0	4.829859	-1.222477	0.843559	0
4.587704	-1.173024	0.715949	0	4.829859	-1.220802	0.844291	0
4.587713	-1.114206	0.665406	0	4.829859	-1.219017	0.844683	0
4.587713	-1.054553	0.616125	0	4.829859	-1.217189	0.844721	0
4.587785	-0.933332	0.520479	0	4.829859	-1.215390	0.844404	0
4.587838	-0.810544	0.427236	1	4.829859	-1.213687	0.843743	0
4.588045	-0.561572	0.245955	0	4.829860	-1.186950	0.830383	0
4.588192	-0.309207	0.069764	1	4.829863	-1.153471	0.812496	0
4.588192	-0.053615	-0.101600	0	4.829879	-1.088119	0.774395	0
4.588194	0.205214	-0.268015	1	4.829890	-1.023848	0.734709	0
4.587929	0.468143	-0.428204	0	4.829921	-0.960001	0.694406	0
4.587557	0.736184	-0.580533	1	4.829964	-0.832955	0.612872	0
4.587231	1.010473	-0.723343	0	4.830021	-0.706602	0.530320	1
4.587141	1.150345	-0.790501	0	4.830184	-0.454726	0.363989	0
4.586978	1.293084	-0.852290	0	4.830307	-0.204095	0.195792	1
4.701628	-1.254444	0.840428	0	4.830368	0.045367	0.025869	0
4.701627	-1.253051	0.841900	0	4.830322	0.293788	-0.145627	1
4.701627	-1.251403	0.843079	0	4.830154	0.540418	-0.319705	0
4.701627	-1.249559	0.843918	0	4.829861	0.784804	-0.497007	1
4.701627	-1.247587	0.844388	0	4.829615	1.026452	-0.678208	0
4.701627	-1.245563	0.844470	0	4.829526	1.146427	-0.770070	0
4.701627	-1.243560	0.844161	0	4.829333	1.266068	-0.861227	0
4.701627	-1.241655	0.843474	0	4.829860	-1.225249	0.841203	0
4.701626	-1.214990	0.830812	0	4.829860	-1.226239	0.839668	0
4.701625	-1.180669	0.813502	0	4.829860	-1.226913	0.837969	0
4.701669	-1.113839	0.776165	0	4.829860	-1.227244	0.836172	0
4.701678	-1.048104	0.737206	0	4.829860	-1.227219	0.834345	0
4.701679	-0.982819	0.697591	0	4.829860	-1.226842	0.832558	0
4.701753	-0.853133	0.617020	0	4.829860	-1.226123	0.830880	0
4.701801	-0.724101	0.535481	1	4.829860	-1.225091	0.829373	0
4.701991	-0.467212	0.370657	0	4.829861	-1.204409	0.804981	0
4.702125	-0.211662	0.203766	1	4.829865	-1.177876	0.776989	0
4.702140	0.042732	0.035069	0	4.829880	-1.122112	0.724938	0
4.702136	0.295691	-0.135740	1	4.829892	-1.064992	0.674847	0
4.701919	0.546717	-0.309462	0	4.829923	-1.006968	0.626072	0
4.701581	0.795285	-0.486782	1	4.829966	-0.889247	0.530972	0
4.701315	1.040781	-0.668596	0	4.830024	-0.770217	0.437769	1
4.701203	1.162494	-0.761043	0	4.830163	-0.529025	0.255913	0
4.701047	1.284011	-0.852713	0	4.830308	-0.284548	0.078745	1
4.701628	-1.254444	0.840428	0	4.830368	-0.037446	-0.094611	0
4.701628	-1.255525	0.838714	0	4.830322	0.212802	-0.263452	1
4.701628	-1.256257	0.836825	0	4.830159	0.466730	-0.426948	0
4.701628	-1.256613	0.834830	0	4.829862	0.725036	-0.583962	1
4.701628	-1.256579	0.832804	0	4.829618	0.988919	-0.732817	0
4.701628	-1.256155	0.830824	0	4.829526	1.123519	-0.803399	0
4.701628	-1.255360	0.828961	0	4.829333	1.260418	-0.869447	0
4.701628	-1.254219	0.827287	0	4.986555	-1.185341	0.838255	0
4.701627	-1.233773	0.802815	0	4.986555	-1.184198	0.839406	0
4.701653	-1.206958	0.774293	0	4.986555	-1.182852	0.840309	0
4.701671	-1.150397	0.721676	0	4.986555	-1.181355	0.840931	0
4.701680	-1.092348	0.671261	0	4.986555	-1.179764	0.841248	0
4.701680	-1.033318	0.622319	0	4.986554	-1.178144	0.841246	0
4.701755	-0.913639	0.526836	0	4.986554	-1.176555	0.840928	0
4.701802	-0.792464	0.433585	1	4.986554	-1.175059	0.840303	0

TABLE A-IV. — Continued. CM-2D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
4.986554	-1.148495	0.826135	0	5.164564	-1.137144	0.829736	0
4.986557	-1.116078	0.807709	0	5.164564	-1.137698	0.828423	0
4.986572	-1.052669	0.768842	0	5.164564	-1.137980	0.827026	0
4.986587	-0.990265	0.728550	0	5.164564	-1.137979	0.825601	0
4.986621	-0.928233	0.687728	0	5.164564	-1.137696	0.824206	0
4.986661	-0.804699	0.605347	0	5.164564	-1.137142	0.822893	0
4.986720	-0.681803	0.522059	1	5.164563	-1.136340	0.821715	0
4.986868	-0.436625	0.354573	0	5.164600	-1.115983	0.797232	0
4.986984	-0.192548	0.185490	1	5.164607	-1.090648	0.770338	0
4.987057	0.050503	0.014927	0	5.164625	-1.037589	0.719830	0
4.987023	0.292706	-0.156879	1	5.164638	-0.983380	0.670891	0
4.986895	0.533290	-0.330948	0	5.164676	-0.928407	0.622992	0
4.986652	0.771888	-0.507802	1	5.164718	-0.816924	0.529313	0
4.986439	1.008070	-0.687979	0	5.164780	-0.704352	0.437121	1
4.986362	1.125451	-0.779085	0	5.164918	-0.476161	0.256864	0
4.986177	1.242570	-0.869436	0	5.165030	-0.245362	0.080143	1
4.986555	-1.185341	0.838255	0	5.165086	-0.012029	-0.093136	0
4.986555	-1.186235	0.836904	0	5.165097	0.223986	-0.262794	1
4.986555	-1.186848	0.835403	0	5.165018	0.463128	-0.428134	0
4.986555	-1.187154	0.833812	0	5.164834	0.706218	-0.588053	1
4.986555	-1.187142	0.832191	0	5.164666	0.954050	-0.741391	0
4.986555	-1.186810	0.830606	0	5.164588	1.080260	-0.814902	0
4.986555	-1.186175	0.829115	0	5.164478	1.208772	-0.884270	0
4.986555	-1.185261	0.827779	0	5.342578	-1.084086	0.818805	0
4.986556	-1.164549	0.803442	0	5.342578	-1.083169	0.819675	0
4.986559	-1.138523	0.775980	0	5.342578	-1.082095	0.820345	0
4.986574	-1.083937	0.724643	0	5.342578	-1.080910	0.820788	0
4.986588	-1.028118	0.675040	0	5.342578	-1.079661	0.820985	0
4.986623	-0.971454	0.626633	0	5.342578	-1.078398	0.820928	0
4.986663	-0.856514	0.532103	0	5.342578	-1.077170	0.820621	0
4.986722	-0.740375	0.439263	1	5.342577	-1.076030	0.820076	0
4.986854	-0.505112	0.257788	0	5.342575	-1.050493	0.804524	0
4.986984	-0.266708	0.080662	1	5.342630	-1.020725	0.785130	0
4.987057	-0.025882	-0.093045	0	5.342655	-0.961915	0.745393	0
4.987023	0.217942	-0.262565	1	5.342669	-0.903901	0.704602	0
4.986900	0.465202	-0.427220	0	5.342664	-0.846062	0.663579	0
4.986653	0.716509	-0.586084	1	5.342757	-0.731212	0.580417	0
4.986441	0.973067	-0.737462	0	5.342802	-0.616605	0.496935	1
4.986362	1.103859	-0.809608	0	5.342959	-0.388011	0.329106	0
4.986178	1.236807	-0.877582	0	5.343077	-0.160118	0.160320	1
5.164564	-1.136341	0.830915	0	5.343147	0.067289	-0.009162	0
5.164564	-1.135322	0.831909	0	5.343180	0.293760	-0.179862	1
5.164563	-1.134124	0.832684	0	5.343140	0.518924	-0.352330	0
5.164563	-1.132797	0.833207	0	5.343015	0.742626	-0.526714	1
5.164563	-1.131393	0.833456	0	5.342885	0.964425	-0.703547	0
5.164563	-1.129969	0.833422	0	5.342821	1.074754	-0.792702	0
5.164563	-1.128578	0.833106	0	5.342743	1.185285	-0.880644	0
5.164563	-1.127278	0.832523	0	5.342578	-1.084086	0.818805	0
5.164559	-1.101183	0.817509	0	5.342579	-1.084811	0.817769	0
5.164605	-1.070123	0.798447	0	5.342579	-1.085315	0.816610	0
5.164623	-1.008988	0.758996	0	5.342579	-1.085577	0.815373	0
5.164636	-0.948747	0.718317	0	5.342578	-1.085587	0.814109	0
5.164672	-0.888853	0.677161	0	5.342578	-1.085343	0.812870	0
5.164716	-0.769492	0.594269	0	5.342578	-1.084857	0.811703	0
5.164777	-0.650712	0.510578	1	5.342578	-1.084148	0.810657	0
5.164917	-0.413561	0.342590	0	5.342576	-1.063991	0.786600	0
5.165029	-0.177361	0.173265	1	5.342632	-1.039611	0.760046	0
5.165086	0.058066	0.002856	0	5.342657	-0.988238	0.710436	0
5.165097	0.292663	-0.168745	1	5.342670	-0.935786	0.662258	0
5.165018	0.525863	-0.342223	0	5.342666	-0.882481	0.615214	0
5.164832	0.757308	-0.518088	1	5.342759	-0.774908	0.522388	0
5.164664	0.986588	-0.696831	0	5.342804	-0.666034	0.431293	1
5.164587	1.100576	-0.787080	0	5.342961	-0.445738	0.252444	0
5.164477	1.214655	-0.876216	0	5.343077	-0.222868	0.076987	1
5.164564	-1.136341	0.830915	0	5.343147	0.002555	-0.095128	0



TABLE A-IV. — Continued. CM-2D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
5.343179	0.230271	-0.264177	1	5.698691	-0.798964	0.661510	0
5.343140	0.460836	-0.429472	0	5.698687	-0.746154	0.621038	0
5.343016	0.695182	-0.589719	1	5.698809	-0.641047	0.539419	0
5.342886	0.933976	-0.743983	0	5.698821	-0.535607	0.458243	1
5.342821	1.055513	-0.818254	0	5.698966	-0.326019	0.294223	0
5.342743	1.179282	-0.888613	0	5.699171	-0.117274	0.129082	1
5.520574	-1.027399	0.801162	0	5.699285	0.091593	-0.035890	0
5.520574	-1.026567	0.801929	0	5.699364	0.299628	-0.201895	1
5.520574	-1.025599	0.802512	0	5.699411	0.506495	-0.369408	0
5.520574	-1.024534	0.802891	0	5.699433	0.712623	-0.537784	1
5.520574	-1.023413	0.803047	0	5.699366	0.916645	-0.708804	0
5.520574	-1.022284	0.802976	0	5.699314	1.018144	-0.794938	0
5.520573	-1.021194	0.802679	0	5.699287	1.120145	-0.879568	0
5.520573	-1.020187	0.802167	0	5.698565	-0.963454	0.775351	0
5.520572	-0.995369	0.786277	0	5.698565	-0.964058	0.774534	0
5.520570	-0.966660	0.767091	0	5.698565	-0.964483	0.773612	0
5.520673	-0.910552	0.727010	0	5.698565	-0.964714	0.772623	0
5.520689	-0.854868	0.686397	0	5.698565	-0.964741	0.771608	0
5.520685	-0.799342	0.645583	0	5.698565	-0.964562	0.770608	0
5.520786	-0.689125	0.562859	0	5.698565	-0.964185	0.769665	0
5.520834	-0.579063	0.479940	1	5.698565	-0.963624	0.768817	0
5.520998	-0.359472	0.313369	0	5.698562	-0.944608	0.745664	0
5.521122	-0.140460	0.146037	1	5.698559	-0.921678	0.721079	0
5.521214	0.078185	-0.021805	0	5.698679	-0.874881	0.673043	0
5.521267	0.295954	-0.190758	1	5.698693	-0.826356	0.627204	0
5.521272	0.512493	-0.361330	0	5.698688	-0.777453	0.581841	0
5.521202	0.727759	-0.533522	1	5.698810	-0.678643	0.492332	0
5.521113	0.941338	-0.707820	0	5.698822	-0.578156	0.404955	1
5.521062	1.047614	-0.795616	0	5.699040	-0.376190	0.231354	0
5.521012	1.154178	-0.882133	0	5.699171	-0.171469	0.061208	1
5.520574	-1.027399	0.801162	0	5.699286	0.035598	-0.106016	0
5.520574	-1.028059	0.800245	0	5.699364	0.244591	-0.270823	1
5.520574	-1.028520	0.799213	0	5.699411	0.455970	-0.432685	0
5.520574	-1.028766	0.798110	0	5.699434	0.671114	-0.589769	1
5.520574	-1.028785	0.796981	0	5.699398	0.889730	-0.742491	0
5.520574	-1.028577	0.795871	0	5.699314	1.000628	-0.816876	0
5.520574	-1.028149	0.794825	0	5.699287	1.113921	-0.887360	0
5.520574	-1.027521	0.793886	0	5.876541	-0.890939	0.739960	0
5.520573	-1.007850	0.770189	0	5.876541	-0.890172	0.740629	0
5.520620	-0.984263	0.744391	0	5.876540	-0.889286	0.741130	0
5.520675	-0.934908	0.695613	0	5.876540	-0.888316	0.741441	0
5.520690	-0.884380	0.648354	0	5.876540	-0.887303	0.741550	0
5.520686	-0.833055	0.602126	0	5.876540	-0.886290	0.741452	0
5.520788	-0.729596	0.510689	0	5.876540	-0.885317	0.741150	0
5.520837	-0.624860	0.420903	1	5.876540	-0.884425	0.740659	0
5.521000	-0.412995	0.244373	0	5.876537	-0.861766	0.725311	0
5.521122	-0.198687	0.070980	1	5.876540	-0.835854	0.706672	0
5.521214	0.018071	-0.099294	0	5.876568	-0.785168	0.667998	0
5.521267	0.236934	-0.266837	1	5.876633	-0.734922	0.628781	0
5.521272	0.458406	-0.431051	0	5.876690	-0.685053	0.589101	0
5.521203	0.683452	-0.590634	1	5.876749	-0.585453	0.509589	0
5.521114	0.912679	-0.744763	0	5.876842	-0.485977	0.429923	1
5.521062	1.029288	-0.819240	0	5.877007	-0.287617	0.269850	0
5.521012	1.148061	-0.890017	0	5.877208	-0.089620	0.109295	1
5.698565	-0.963454	0.775351	0	5.877370	0.107815	-0.051970	0
5.698565	-0.962698	0.776030	0	5.877470	0.304893	-0.213638	1
5.698565	-0.961821	0.776542	0	5.877561	0.501293	-0.376140	0
5.698565	-0.960858	0.776865	0	5.877631	0.696275	-0.540370	1
5.698565	-0.959849	0.776988	0	5.877638	0.889842	-0.706295	0
5.698565	-0.958838	0.776904	0	5.877620	0.986273	-0.789678	0
5.698565	-0.957863	0.776617	0	5.877565	1.082720	-0.872256	0
5.698565	-0.956965	0.776142	0	5.876541	-0.890939	0.739960	0
5.698562	-0.933037	0.760155	0	5.876541	-0.891554	0.739148	0
5.698559	-0.905483	0.741363	0	5.876540	-0.891992	0.738230	0
5.698678	-0.852279	0.701351	0	5.876540	-0.892233	0.737242	0

TABLE A-IV. — Continued. CM-2D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
5.876540	-0.892270	0.736225	0	6.055885	0.837000	-0.729167	0
5.876540	-0.892100	0.735223	0	6.055892	0.935695	-0.799839	0
5.876540	-0.891730	0.734276	0	6.055879	1.036117	-0.867700	0
5.876540	-0.891174	0.733423	0	6.232492	-0.725477	0.643444	0
5.876538	-0.873104	0.711505	0	6.232492	-0.724690	0.644096	0
5.876541	-0.851463	0.687662	0	6.232492	-0.723787	0.644578	0
5.876569	-0.806676	0.641804	0	6.232492	-0.722805	0.644866	0
5.876691	-0.761124	0.596849	0	6.232492	-0.721785	0.644949	0
5.876690	-0.714552	0.553177	0	6.232492	-0.720770	0.644825	0
5.876825	-0.621172	0.466057	0	6.232492	-0.719800	0.644498	0
5.876843	-0.525852	0.381359	1	6.232492	-0.718919	0.643980	0
5.877007	-0.334136	0.213196	0	6.232493	-0.699597	0.629834	0
5.877206	-0.140187	0.047713	1	6.232500	-0.677043	0.612371	0
5.877371	0.055587	-0.115575	0	6.232536	-0.632909	0.576305	0
5.877470	0.253557	-0.276159	1	6.232594	-0.588902	0.540114	0
5.877561	0.454131	-0.433575	0	6.232702	-0.545470	0.503222	0
5.877631	0.657418	-0.587691	1	6.232789	-0.458295	0.429854	0
5.877641	0.864320	-0.737373	0	6.232904	-0.371711	0.355765	1
5.877621	0.969536	-0.810060	0	6.233108	-0.198479	0.207681	0
5.877566	1.076395	-0.879959	0	6.233348	-0.025156	0.059713	1
6.054515	-0.810659	0.695550	0	6.233530	0.147519	-0.089034	0
6.054515	-0.809883	0.696212	0	6.233736	0.319685	-0.238415	1
6.054515	-0.808988	0.696703	0	6.233872	0.491288	-0.388405	0
6.054515	-0.808011	0.697003	0	6.234034	0.661896	-0.539544	1
6.054515	-0.806994	0.697100	0	6.234127	0.831392	-0.691945	0
6.054515	-0.805978	0.696989	0	6.234157	0.915754	-0.768607	0
6.054515	-0.805006	0.696675	0	6.234165	1.000468	-0.844137	0
6.054515	-0.804119	0.696171	0	6.232492	-0.725477	0.643444	0
6.054515	-0.783147	0.681274	0	6.232492	-0.726113	0.642645	0
6.054520	-0.758881	0.663134	0	6.232492	-0.726573	0.641733	0
6.054553	-0.711396	0.625603	0	6.232492	-0.726838	0.640749	0
6.054615	-0.664219	0.587710	0	6.232492	-0.726896	0.639732	0
6.054690	-0.617459	0.549309	0	6.232492	-0.726745	0.638723	0
6.054770	-0.523791	0.472712	0	6.232492	-0.726393	0.637767	0
6.054870	-0.430725	0.395379	1	6.232492	-0.725852	0.636902	0
6.055055	-0.244601	0.240707	0	6.232495	-0.710518	0.617226	0
6.055284	-0.058770	0.085653	1	6.232502	-0.691599	0.595566	0
6.055465	0.126584	-0.069987	0	6.232538	-0.652476	0.553714	0
6.055606	0.311831	-0.225723	1	6.232592	-0.612195	0.513224	0
6.055712	0.496100	-0.382621	0	6.232705	-0.571844	0.472773	0
6.055830	0.679256	-0.540848	1	6.232789	-0.489573	0.393747	0
6.055883	0.861142	-0.700556	0	6.232906	-0.406898	0.315141	1
6.055891	0.951730	-0.780834	0	6.233108	-0.239296	0.160559	0
6.055877	1.042539	-0.860091	0	6.233346	-0.069384	0.008657	1
6.054515	-0.810659	0.695550	0	6.233526	0.101909	-0.141685	0
6.054515	-0.811284	0.694746	0	6.233738	0.274819	-0.290208	1
6.054515	-0.811733	0.693831	0	6.233873	0.449977	-0.436094	0
6.054515	-0.811986	0.692845	0	6.234034	0.627665	-0.579059	1
6.054515	-0.812032	0.691829	0	6.234127	0.808513	-0.718354	0
6.054515	-0.811871	0.690824	0	6.234186	0.900753	-0.785853	0
6.054515	-0.811508	0.689873	0	6.234166	0.993943	-0.851669	0
6.054515	-0.810960	0.689014	0	6.410497	-0.636337	0.584185	0
6.054516	-0.794274	0.668086	0	6.410497	-0.635543	0.584830	0
6.054521	-0.773947	0.645279	0	6.410497	-0.634634	0.585301	0
6.054554	-0.731900	0.601301	0	6.410497	-0.633648	0.585578	0
6.054611	-0.688756	0.558630	0	6.410497	-0.632626	0.585650	0
6.054692	-0.645333	0.516270	0	6.410497	-0.631612	0.585514	0
6.054769	-0.556994	0.433361	0	6.410497	-0.630646	0.585176	0
6.054872	-0.468159	0.351010	1	6.410497	-0.629771	0.584647	0
6.055055	-0.288153	0.189088	0	6.410500	-0.612147	0.571403	0
6.055282	-0.106042	0.029626	1	6.410507	-0.591348	0.554785	0
6.055465	0.077788	-0.127822	0	6.410575	-0.550310	0.520943	0
6.055608	0.263880	-0.282553	1	6.410604	-0.509958	0.486293	0
6.055713	0.451989	-0.434901	0	6.410728	-0.469961	0.451220	0
6.055830	0.642811	-0.584042	1	6.410819	-0.389499	0.381683	0



TABLE A-IV. — Continued. CM-2D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
6.410951	-0.309652	0.311397	1	6.588549	-0.542549	0.509583	0
6.411222	-0.149419	0.171510	0	6.588550	-0.530077	0.492841	0
6.411436	0.010208	0.030895	1	6.588555	-0.514168	0.473894	0
6.411638	0.169628	-0.109951	0	6.588625	-0.480916	0.437607	0
6.411875	0.328493	-0.251474	1	6.588653	-0.447203	0.401792	0
6.412057	0.487226	-0.393042	0	6.588790	-0.413390	0.366043	0
6.412241	0.644374	-0.536521	1	6.588884	-0.344062	0.296537	0
6.412368	0.800910	-0.680597	0	6.589030	-0.274595	0.227099	1
6.412439	0.879179	-0.752581	0	6.589313	-0.133134	0.091125	0
6.412445	0.957045	-0.824492	0	6.589544	0.009619	-0.043481	1
6.410497	-0.636337	0.584185	0	6.589758	0.153889	-0.176420	0
6.410497	-0.636983	0.583392	0	6.590030	0.299705	-0.307665	1
6.410497	-0.637454	0.582486	0	6.590224	0.447259	-0.436994	0
6.410497	-0.637731	0.581504	0	6.590448	0.596964	-0.563962	1
6.410498	-0.637801	0.580486	0	6.590605	0.749256	-0.688088	0
6.410498	-0.637662	0.579475	0	6.590672	0.826669	-0.748763	0
6.410498	-0.637320	0.578515	0	6.590695	0.905145	-0.807740	0
6.410498	-0.636790	0.577644	0	6.766634	-0.438650	0.435338	0
6.410501	-0.622860	0.559344	0	6.766634	-0.437843	0.435972	0
6.410510	-0.605415	0.538951	0	6.766634	-0.436925	0.436430	0
6.410578	-0.568983	0.499926	0	6.766634	-0.435933	0.436695	0
6.410604	-0.532075	0.461402	0	6.766633	-0.434907	0.436754	0
6.410732	-0.494925	0.423120	0	6.766633	-0.433894	0.436604	0
6.410819	-0.418966	0.348518	0	6.766633	-0.432932	0.436255	0
6.410954	-0.342730	0.274163	1	6.766633	-0.432062	0.435718	0
6.411225	-0.187664	0.128464	0	6.766629	-0.418068	0.424921	0
6.411434	-0.031187	-0.015693	1	6.766674	-0.400791	0.410973	0
6.411635	0.126948	-0.157985	0	6.766716	-0.367525	0.381587	0
6.411878	0.286504	-0.298736	1	6.766761	-0.334460	0.352004	0
6.412058	0.448540	-0.436582	0	6.766838	-0.301500	0.322314	0
6.412241	0.612207	-0.572723	1	6.766994	-0.236062	0.262375	0
6.412367	0.779202	-0.705027	0	6.767166	-0.170581	0.202505	1
6.412440	0.864386	-0.769229	0	6.767426	-0.040015	0.082305	0
6.412445	0.950417	-0.831951	0	6.767676	0.090422	-0.038027	1
6.588548	-0.542027	0.516120	0	6.767902	0.220693	-0.158528	0
6.588548	-0.541226	0.516757	0	6.768176	0.350641	-0.279386	1
6.588548	-0.540311	0.517220	0	6.768383	0.479984	-0.400902	0
6.588548	-0.539322	0.517489	0	6.768589	0.608616	-0.523173	1
6.588547	-0.538299	0.517552	0	6.768808	0.736384	-0.646368	0
6.588547	-0.537284	0.517406	0	6.768886	0.799949	-0.708323	0
6.588547	-0.536321	0.517058	0	6.768937	0.863720	-0.769518	0
6.588547	-0.535451	0.516524	0	6.766634	-0.438650	0.435338	0
6.588547	-0.519585	0.504372	0	6.766634	-0.439312	0.434555	0
6.588551	-0.500607	0.488798	0	6.766634	-0.439800	0.433656	0
6.588621	-0.463166	0.457111	0	6.766635	-0.440095	0.432679	0
6.588653	-0.426305	0.424755	0	6.766635	-0.440185	0.431662	0
6.588784	-0.389868	0.391896	0	6.766635	-0.440065	0.430650	0
6.588882	-0.316451	0.326877	0	6.766635	-0.439741	0.429685	0
6.589024	-0.243663	0.261094	1	6.766635	-0.439225	0.428806	0
6.589308	-0.097513	0.130264	0	6.766634	-0.428303	0.413916	0
6.589545	0.048122	-0.001177	1	6.766686	-0.413744	0.397050	0
6.589762	0.193577	-0.132813	0	6.766723	-0.384223	0.363644	0
6.590026	0.338740	-0.264773	1	6.766759	-0.353973	0.331034	0
6.590223	0.483279	-0.397418	0	6.766839	-0.323353	0.298824	0
6.590450	0.627016	-0.530943	1	6.766994	-0.261575	0.234959	0
6.590607	0.769753	-0.665567	0	6.767182	-0.199050	0.171907	1
6.590672	0.840850	-0.733183	0	6.767432	-0.072685	0.047197	0
6.590696	0.911870	-0.800350	0	6.767674	0.055172	-0.075906	1
6.588548	-0.542027	0.516120	0	6.767894	0.184365	-0.197574	0
6.588548	-0.542682	0.515334	0	6.768182	0.314901	-0.317799	1
6.588548	-0.543163	0.514431	0	6.768384	0.446965	-0.436384	0
6.588548	-0.543450	0.513452	0	6.768585	0.580935	-0.552918	1
6.588548	-0.543531	0.512435	0	6.768802	0.717236	-0.666948	0
6.588548	-0.543403	0.511423	0	6.768885	0.786468	-0.722810	0
6.588549	-0.543071	0.510459	0	6.768935	0.856904	-0.776843	0

TABLE A-IV. — Concluded. CM-2D AFT COLD SHAPE COORDINATES  
[Number of cross sectional cuts, 24; number of points on each side of blade, 24.]

X	Y	Z		X	Y	Z	
6.944846	-0.320037	0.336021	0	6.947054	0.741858	-0.689035	0
6.944845	-0.319232	0.336656	0	6.947116	0.802521	-0.737496	0
6.944844	-0.318315	0.337117	0	7.123119	-0.178999	0.209362	0
6.944843	-0.317325	0.337383	0	7.123119	-0.178216	0.210025	0
6.944842	-0.316302	0.337445	0	7.123118	-0.177315	0.210517	0
6.944840	-0.315290	0.337299	0	7.123117	-0.176336	0.210818	0
6.944839	-0.314328	0.336952	0	7.123116	-0.175317	0.210915	0
6.944839	-0.313459	0.336418	0	7.123116	-0.174303	0.210805	0
6.944831	-0.301573	0.327281	0	7.123116	-0.173334	0.210491	0
6.944841	-0.286759	0.314679	0	7.123116	-0.172450	0.209988	0
6.944894	-0.257779	0.288783	0	7.123119	-0.162813	0.203041	0
6.944985	-0.228990	0.262708	0	7.123160	-0.150443	0.192763	0
6.945018	-0.200087	0.236795	0	7.123213	-0.125978	0.171984	0
6.945160	-0.143378	0.183656	0	7.123240	-0.102018	0.150637	0
6.945315	-0.086505	0.130748	1	7.123257	-0.078215	0.129129	0
6.945576	0.026894	0.024544	0	7.123417	-0.030989	0.085723	0
6.945818	0.140125	-0.081825	1	7.123466	0.016053	0.042123	1
6.946071	0.253354	-0.188142	0	7.123766	0.109549	-0.045681	0
6.946299	0.365758	-0.295431	1	7.123968	0.202570	-0.133980	1
6.946516	0.477747	-0.403126	0	7.124155	0.295104	-0.222784	0
6.946730	0.589081	-0.511495	1	7.124351	0.387115	-0.312129	1
6.946988	0.699811	-0.620439	0	7.124558	0.478427	-0.402197	0
6.947055	0.754460	-0.675766	0	7.124858	0.568862	-0.493170	1
6.947120	0.809433	-0.730212	0	7.125060	0.658185	-0.585291	0
6.944846	-0.320037	0.336021	0	7.125114	0.702371	-0.631842	0
6.944846	-0.320696	0.335238	0	7.125212	0.745869	-0.678774	0
6.944847	-0.321184	0.334338	0	7.123119	-0.178999	0.209362	0
6.944848	-0.321478	0.333360	0	7.123120	-0.179634	0.208557	0
6.944848	-0.321568	0.332343	0	7.123121	-0.180093	0.207642	0
6.944848	-0.321449	0.331331	0	7.123122	-0.180359	0.206653	0
6.944848	-0.321128	0.330365	0	7.123123	-0.180420	0.205634	0
6.944848	-0.320615	0.329485	0	7.123123	-0.180273	0.204625	0
6.944848	-0.311434	0.316890	0	7.123124	-0.179926	0.203669	0
6.944859	-0.298958	0.301826	0	7.123124	-0.179392	0.202803	0
6.944899	-0.273156	0.272590	0	7.123129	-0.172152	0.193378	0
6.944983	-0.246790	0.243960	0	7.123171	-0.161594	0.181231	0
6.945016	-0.219811	0.216032	0	7.123216	-0.139609	0.157896	0
6.945156	-0.166305	0.159513	0	7.123240	-0.117533	0.134604	0
6.945335	-0.111968	0.103929	1	7.123261	-0.095277	0.111495	0
6.945580	-0.002152	-0.006041	0	7.123415	-0.050526	0.065530	0
6.945811	0.108856	-0.114754	1	7.123464	-0.005443	0.019906	1
6.946068	0.221255	-0.221931	0	7.123768	0.085217	-0.070829	0
6.946314	0.334058	-0.328825	1	7.123965	0.176512	-0.160912	1
6.946518	0.448412	-0.434018	0	7.124157	0.268353	-0.250431	0
6.946723	0.564316	-0.537575	1	7.124353	0.360759	-0.339368	1
6.946984	0.682394	-0.638773	0	7.124554	0.453879	-0.427567	0
				7.124858	0.547904	-0.514829	1
				7.125059	0.642967	-0.601019	0
				7.125111	0.690946	-0.643649	0
				7.125201	0.738871	-0.686019	0



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13. ABSTRACT (Maximum 200 words)  One of the propulsion concepts being investigated for future cruise missiles is advanced unducted propfans. To support the evaluation of this technology applied to the cruise missile, a joint DOD and NASA test project was conducted to design and then test the characteristics of the propfans on a 0.55-scale, cruise missile model in a NASA wind tunnel (ref. 1). The configuration selected for study is a counterrotating rearward swept propfan. The forward blade row, having six blades, rotates in a counterclockwise direction, and the aft blade row, having six blades, rotates in a clockwise direction, as viewed from aft of the test model. Figures 1 and 2 show the overall cruise missile and propfan blade configurations. The objective of this test was to evaluate propfan performance and suitability as a viable propulsion option for next generation of cruise missiles. This paper details the concurrent computer aided design, engineering, and manufacturing of the carbon fiber/epoxy propfan blades at the NASA Lewis Research Center.				
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